POWER

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Likely Looking Material

"THEN, if they are likely looking material we try them out on some of the bigger leads."

The Big Boss was telling how they selected and trained the personnel for a large and growing industry.

And that phrase "if they are likely looking material" stuck in my mind.

I imagined him and his associates watching these young men that they had gathered from the technical schools, from drafting rooms and power plants and sales organizations and put at minor tasks to demonstrate their capacity for greater responsibilities.

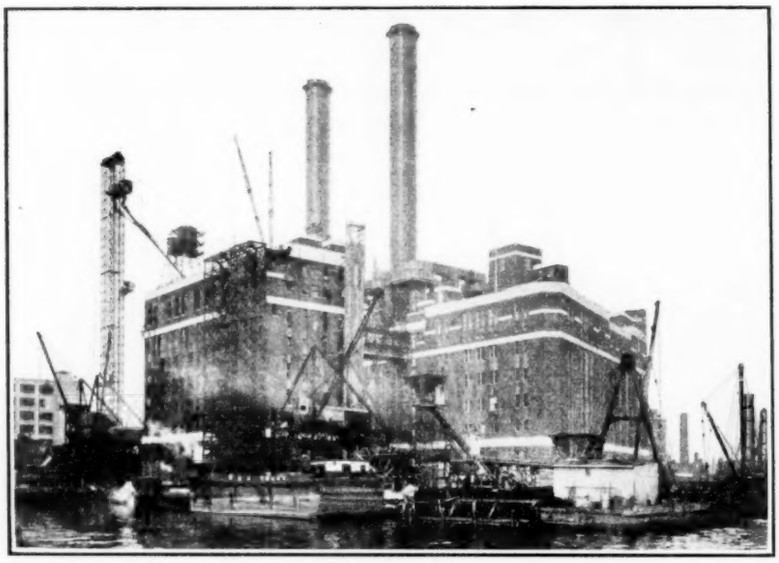
And I wondered what men in their position would look for—upon what points these unconscious competitors for preferment and advancement would be judged.

Of course, the work that a man did and the way that he did it would be a major consideration, and the man who demonstrated that he could be leaned upon hard and come back with something intelligently done for the doing of which the executive was striving, would invite further and more important tests.

But are there not other and less obvious points that these pickers of men look for? Disposition and gentlemanly behavior, their manner of meeting people and the people with whom they associate; the style and substance of their conversation, their habits of thought and of living, out of hours as well as on the job; what they read, even for daily papers, their views upon the questions of the day, their personal appearance and presentability—those things that are summed up in the word Character—may have much to do with their being considered well groomed "likely looking material" for the bigger lead.

The technique of the job can be taught, facility can be acquired, but character is the prime essential for the man in the big position, and that, I surmise, is what the Boss is looking for.

F. R. Low



The new station was put into operation by Queen Marie last November

New East River Station

of the New York Edison Co.

THIS station, now nearing completion, constitutes the first section of what will ultimately be a million kilowatt plant. With an initial generating capacity of 120,000 kw. it will meet the increased demand on the 25-cycle system of the New York Edison Company and, through a 40,000-kw. 25- to 60-cycle frequency changer, ties in with the 60-cycle systems of the Brooklyn Edison Company and the United Electric Light & Power Company. The plant is on the East River at Fourteenth Street and carries the load of the southern half of Manhattan.

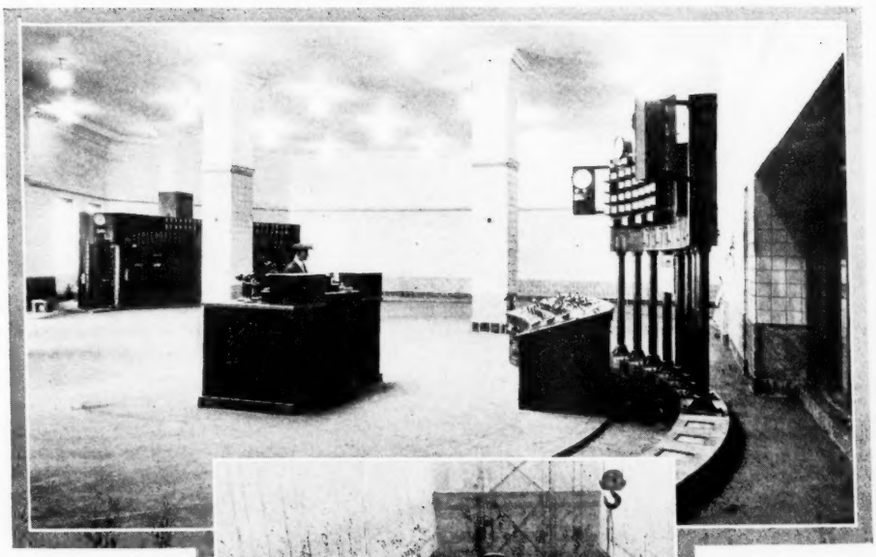
It is the first power station to burn pulverized coal on a large scale in New York City. The bin and feeder system is employed, with the coal preparation plant in a separate building. This also contains the air compressors and a house turbine which supplies part of the millhouse motor load and exhausts to the driers. The cinder problem has been met by first passing the flue gases through a wet cinder catcher and then a cyclone to catch the fine dust.

Steam is generated at 375 lb. and 700 deg. in six cross-drum boilers each having 14,809 sq.ft. of heating surface, exclusive of water walls or superheaters, and capable of producing on continuous overload 250,000 lb. of steam per hour. The combustion chambers are entirely inclosed by water-cooled walls of the Murray fin-tube type, no brickwork or refractories being used. Radiation is prevented by a plastic coating on the outside, away from the fire, from four to six inches thick.

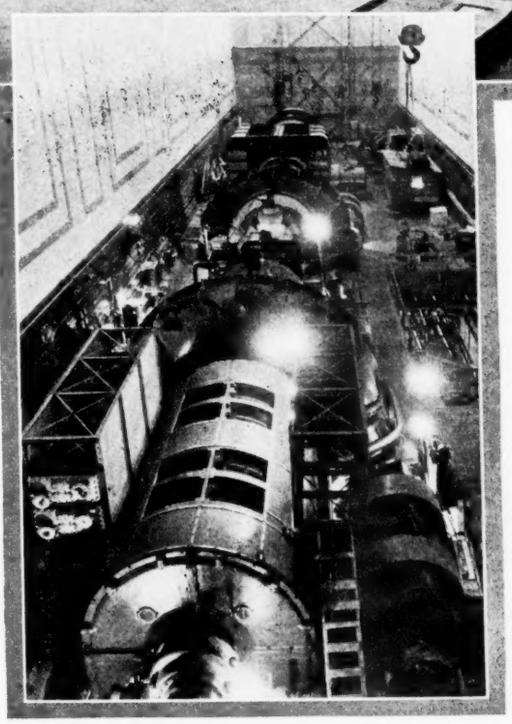
The two main units are 60,000-kw. 25-cycle, 20-stage single-shaft machines, bled at three points. They exhaust to 45,000-sq.ft. single-pass surface condensers, each served by duplicate hotwell, circulating and steam-jet air pumps. Intake and discharge tunnels are short with supply pipes, embedded in the foundation, leading to the pumps. These (including future units) are concentrated in one end of the basement. Thermostatic control will regulate the circulating pump speed to maintain a constant temperature of water leaving the condenser.

Lowest combined fixed and operating charges, consistent with the extreme reliability demanded, dictated the choice of turbine drive for essential auxiliaries such as circulating boiler feed and hotwell pumps, fans, etc., d.c. motors for fuel feeders and miscellaneous small motors, and a.c. motors for non-essential drives. Duplex units are also employed. House turbo-generators, step-down transformers on the main bus and a storage battery form the auxiliary electrical supply.

Among other mechanical features of the station may be mentioned 22x375-ft. unlined steel stacks, plate-type air preheaters, automatic combustion control on all the boilers combined with feed-water regulators, and deconcentrators installed on all boilers. Water sluicing of the ash is employed. The generator air coolers and the oil coolers are supplied with water from the condenser circulating system. Some of the foregoing will be described in greater detail in subsequent articles.



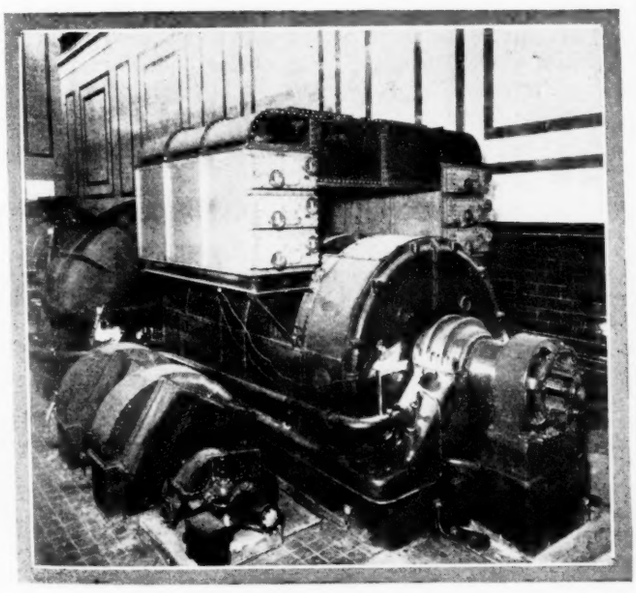
The control room on the fifth floor commands a view of the turbine room. It contains the customary generator and feeder boards

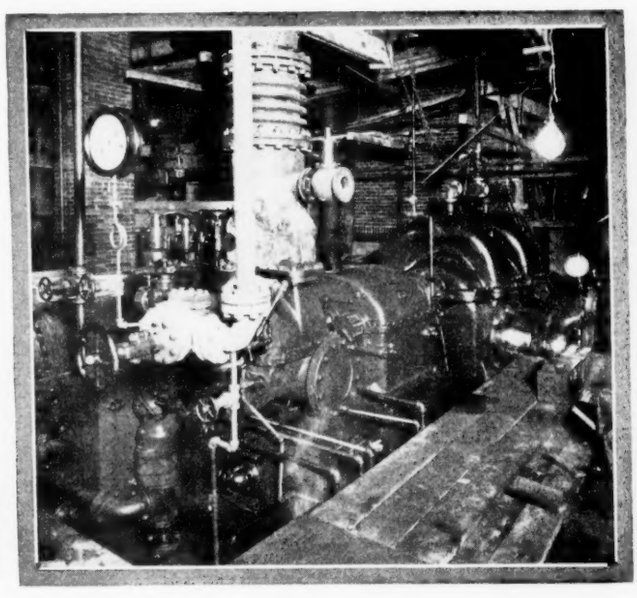


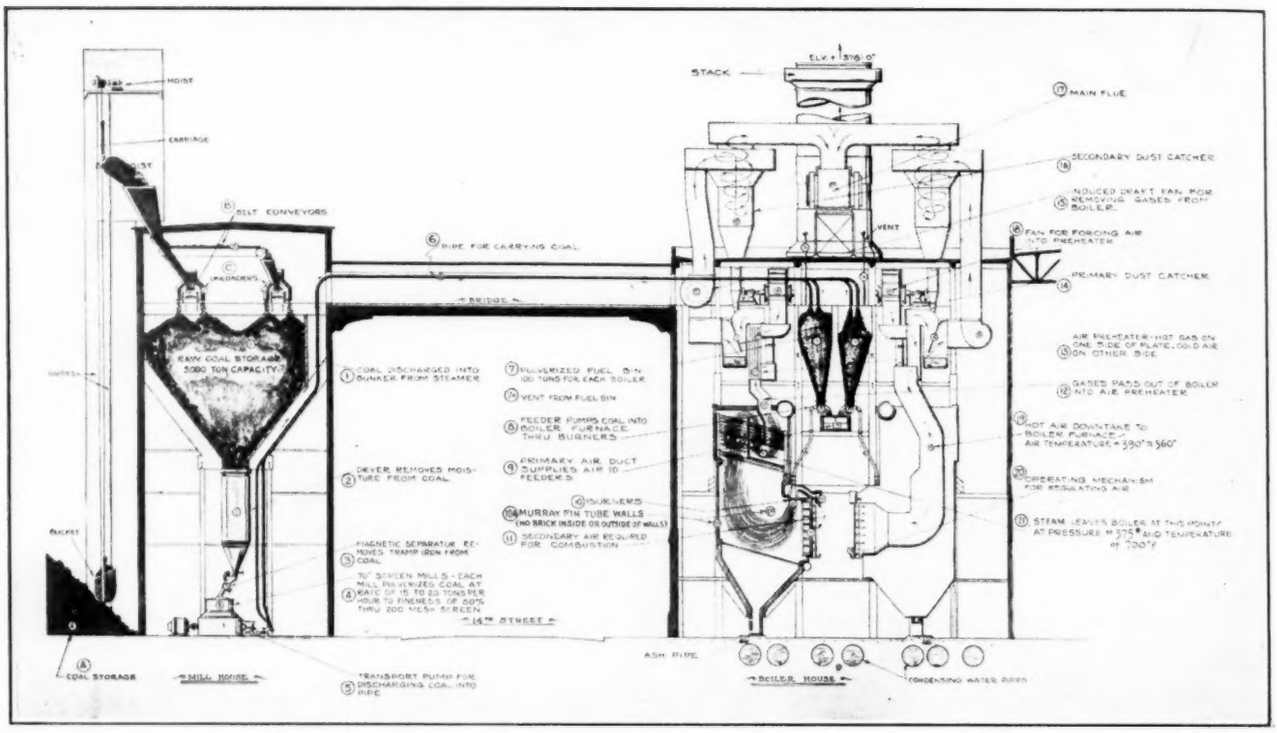
Property limitations have dictated a long narrow turbine room. This will ultimately extend over 800 ft. to accommodate nine turbine-generators and two frequency changers. Its present length is 245 ft.

The air cooler is above the generator and consists of nests of spiral finned tubes. It is served by two motor-driven blowers supplying 110,000 cu.ft. of air per minute in a closed system. Cooling water is taken from the condenser circulating system

Each condenser is provided with two 42-in. double-suction turbine-driven pumps rated at 45,000 g.p.m. but capable, when only one pump is operating, of discharging 57,500 g.p.m.






STACK
ELV. + 376'-0"
MAIN FLUE
SECONDARY DUST CATCHER
INDUCED DRAFT FAN FOR REMOVING GASES FROM BOILER
FAN FOR FORCING AIR INTO PREHEATER
PRIMARY DUST CATCHER
AIR PREHEATER - HOT GAS ON ONE SIDE OF PLATE, COLD AIR ON OTHER SIDE
GASES PASS OUT OF BOILER INTO AIR PREHEATER
HOT AIR DOWNTAKE TO BOILER FURNACE - AIR TEMPERATURE = 530° TO 560°
OPERATING MECHANISM FOR REGULATING AIR
STEAM LEAVES BOILER AT THIS POINT AT PRESSURE OF 375# AND TEMPERATURE OF 700°F
BELT CONVEYORS
PIPE FOR CARRYING COAL
BRIDGE
VENT
MOIST
CARRIAGE
BUCKET
RAW COAL STORAGE 5000 TON CAPACITY
LOADERS
1 COAL DISCHARGED INTO BUNKER FROM STEAMER
2 DRYER REMOVES MOISTURE FROM COAL
3 MAGNETIC SEPARATOR REMOVES TRAMP IRON FROM COAL
4 TWO SCREEN MILLS - EACH MILL PULVERIZES COAL AT RATE OF 15 TO 20 TONS PER HOUR TO FINENESS OF 80% THRU 200 MESH SCREEN
5 TRANSPORT PUMP FOR DISCHARGING COAL INTO PIPE
6 PIPE FOR CARRYING COAL
7 PULVERIZED FUEL BIN 100 TONS FOR EACH BOILER
8 FEEDER PUMPS COAL INTO BOILER FURNACE THRU BURNERS
9 PRIMARY AIR DUCT SUPPLIES AIR TO FEEDERS
10 BURNERS
12 MURRAY FIN TUBE WALLS (NO BRICK INSIDE OR OUTSIDE OF WALLS)
11 SECONDARY AIR REQUIRED FOR COMBUSTION
14TH STREET
A COAL STORAGE
MILL HOUSE
ASH PIPE
BOILER HOUSE
CONDENSING WATER PIPES

Layout of fuel preparation and steam generating equipment at East River Station

From Barge to Boiler

TEN-THOUSAND-TON ocean-going barges will deliver coal direct to the bulkhead of the station, where it will be unloaded by two electrically operated traveling coal towers, each carrying a ring-type crusher. From the crusher the coal may be fed either onto a conveyor, which dumps it on the landward side of the tower, to be taken to the 48,000-ton outdoor storage by drag scrapers, or it may be fed to a series of belt conveyors which supply the raw coal bunkers in the millhouse. The latter is on the south side of Fourteenth Street and connects with the main building by a bridge.

There are two driers per mill. These are rectangular in section and contain cast-iron steam grids through which the coal passes down to the mill feeders. The moisture-laden air from the driers is drawn into a horizontal flue from which it is exhausted by three motor-driven fans and discharged into six cyclone dust collectors. Dust caught in the collectors is discharged into the transport pumps. When necessary, the driers may be emptied into a handcar.

Pulverizers Insulated Against Vibration

The pulverizers are on the ground floor of the millhouse immediately below the driers, and to lessen vibration the foundations are cork-insulated. Each mill is of 15 tons capacity and is provided with two motor-driven feeders which regulate the flow of coal from the driers to the mill. Between the feeders and the mill are magnetic separators. The mills are each driven by a 250-hp. 375-r.p.m. alternating-current motor supplied by the turbine-generator in the millhouse.

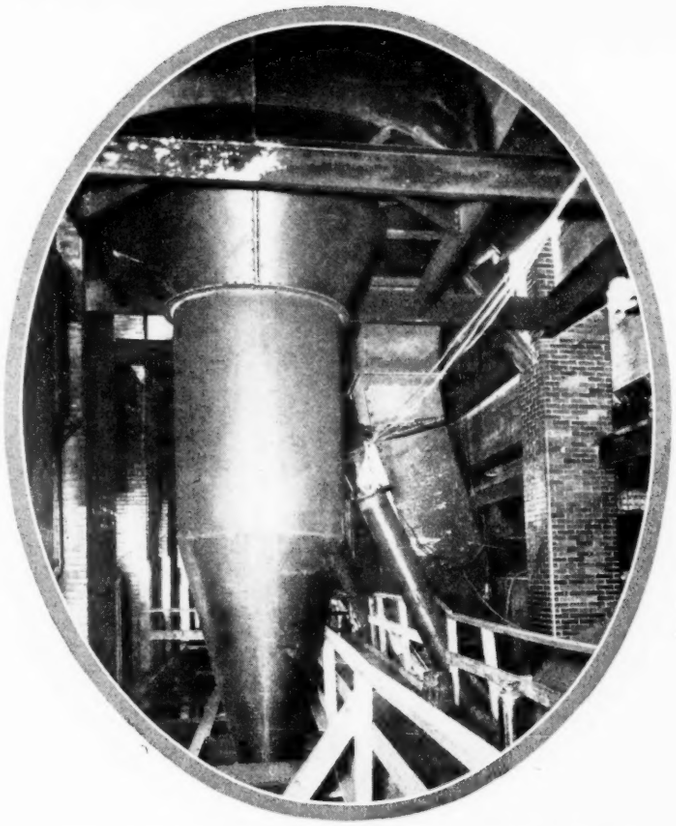
The pulverized coal from the mill passes directly to the transporters, of which there is one per mill. These are vented through the exhauster flue to the dust collectors. They have a capacity of 25 tons per hour and are connected into a transport pipe system, which carries the coal in two 10-in. headers across the bridge over Fourteenth Street to the boiler house.

In the boiler house the coal may be sent directly to the 100-ton individual boiler bins, or may be first diverted to the two 10-ton weight bins and retransported to the boiler bins. From the latter the coal is fed by direct-current motor-driven feeders to the burners, of which there are ten per boiler. The vertical system of firing is employed.

An automatic bin indicating system will be installed to indicate the level of the powdered coal in each of the individual boiler bins. It will consist of floats that are continuously raised and lowered in the bins by means of cams driven from either one of two revolving shafts that extend the length of the boiler room. Upon lowering, the float comes in contact with the top of the powdered coal and its position is indicated on a calibrated scale located at the boiler operating floor.

Power Supply to Coal Preparation Plant

The millhouse contains four motor-driven air compressors which furnish compressed air for the transporters, and a steam-driven geared 1,000-kw. three-phase house alternator. The latter exhausts at 3 lb. back pressure to the coal driers. Power generated by this machine is used to take a portion of the load of the millhouse motors, the amount generated being dependent upon the steam required by the driers. The difference between the generated power and the millhouse load is supplied from the 2,300-volt power transformers. There is also an emergency steam connection to the driers from the high-pressure steam line through reducing valves.

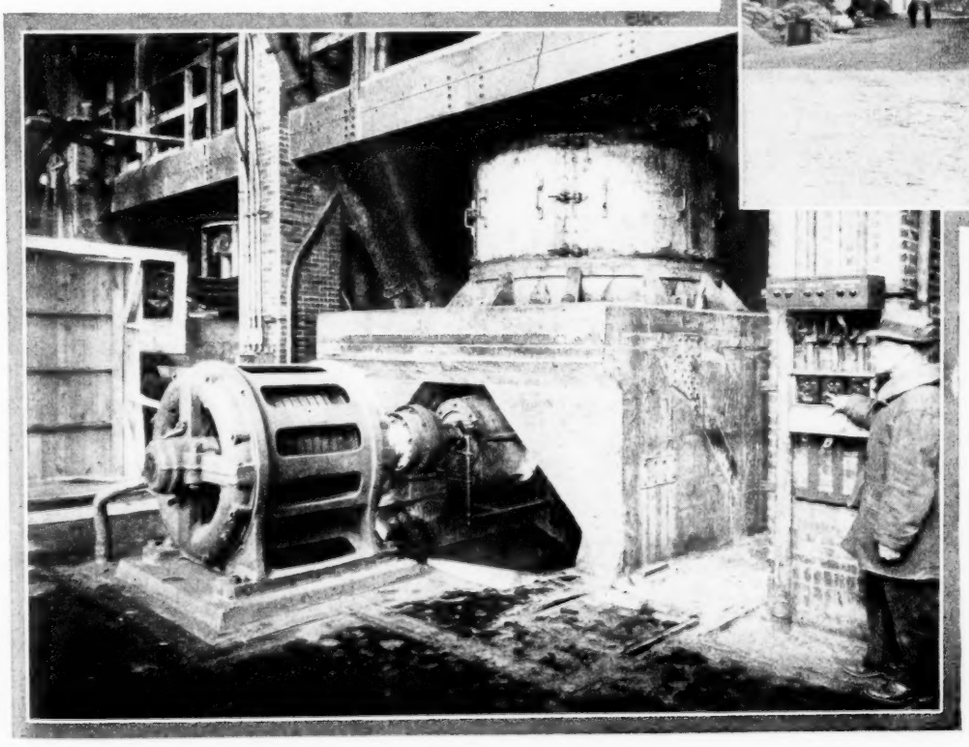


One of the cyclone dust collectors on the mill vents

Seen in the

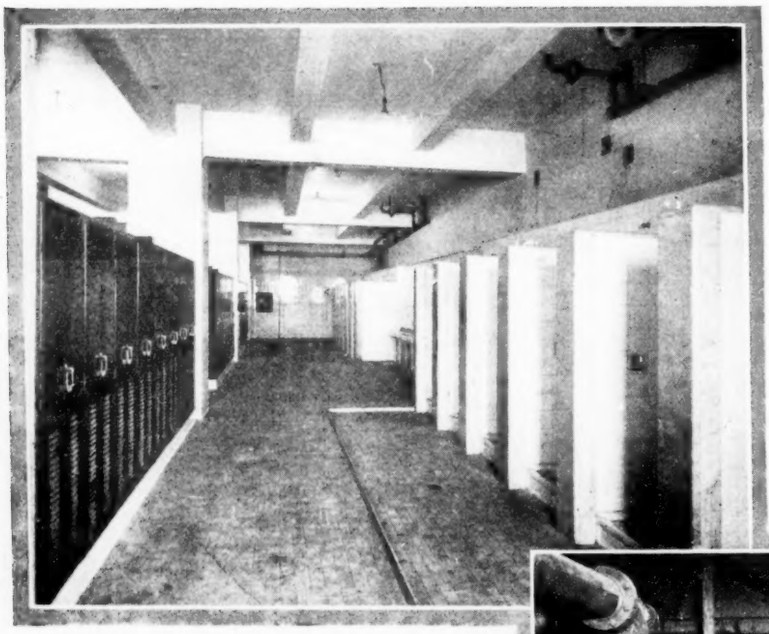
Coal Preparation Plant

There are six of these 15-ton ball-type mills, each driven by a 250-hp. motor

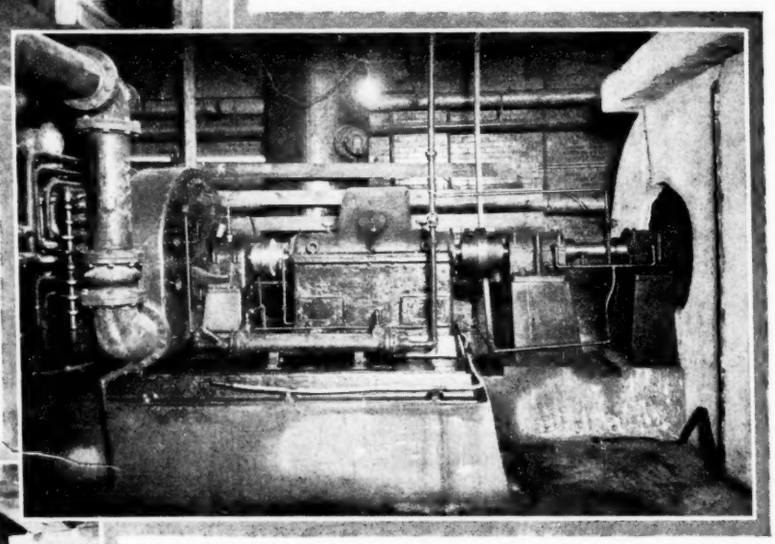


This bridge connects the main building with the mill house and carries the coal transport pipes to the boiler room

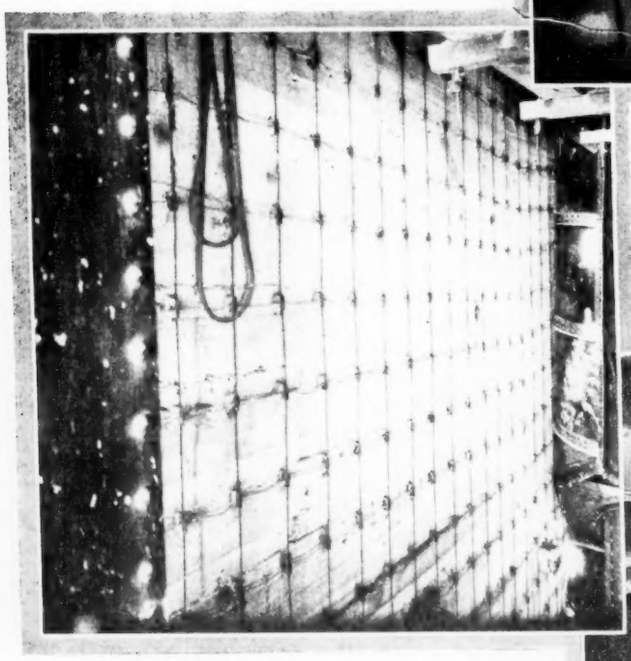
Concerning the Boi



Although not a part of the boiler plant, this white-tiled shower and locker room is very popular with the boiler-room crew. It has accommodations for a force of about 800 men

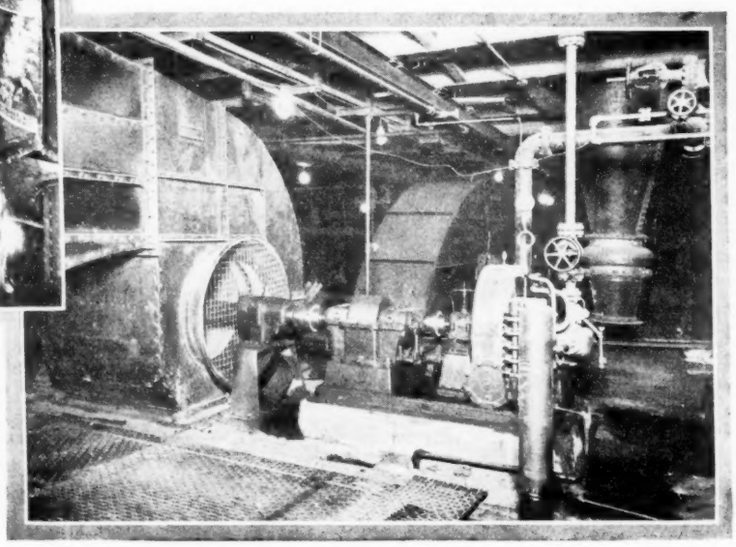


Each boiler is served by an induced-draft fan (right), of 150,000 cu.ft. per min. capacity, driven through reduction gears by a 400-hp. turbine

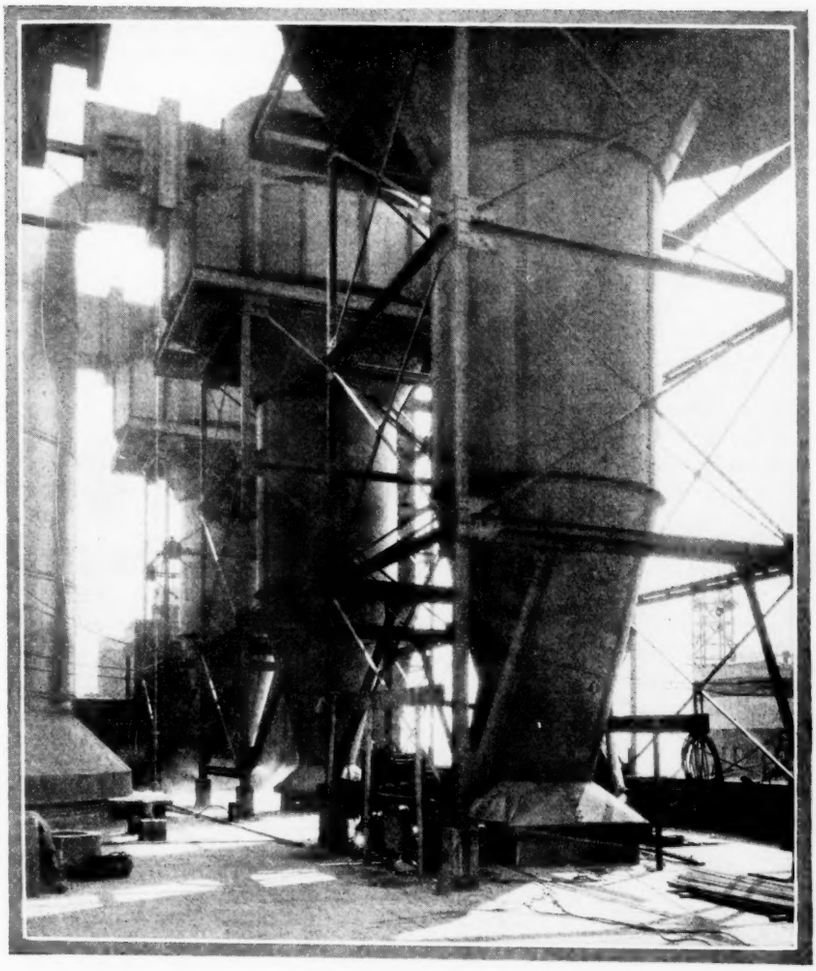


Two inches of diatomaceous earth, bonded with cement, is placed outside the fins of the water walls and fills the spaces between the tubes. Outside this is 4 in. of cement reinforced with ½-in. rods welded to clips attached to the tubes. Then ½ in. of hard finish is applied and painted

The forced-draft fans, (below) are just under the roof and have a capacity of 75,000 cu.ft. per min. at 6.4 in. static pressure. Each is driven by a 115-hp. steam turbine through a 4 to 1 gear

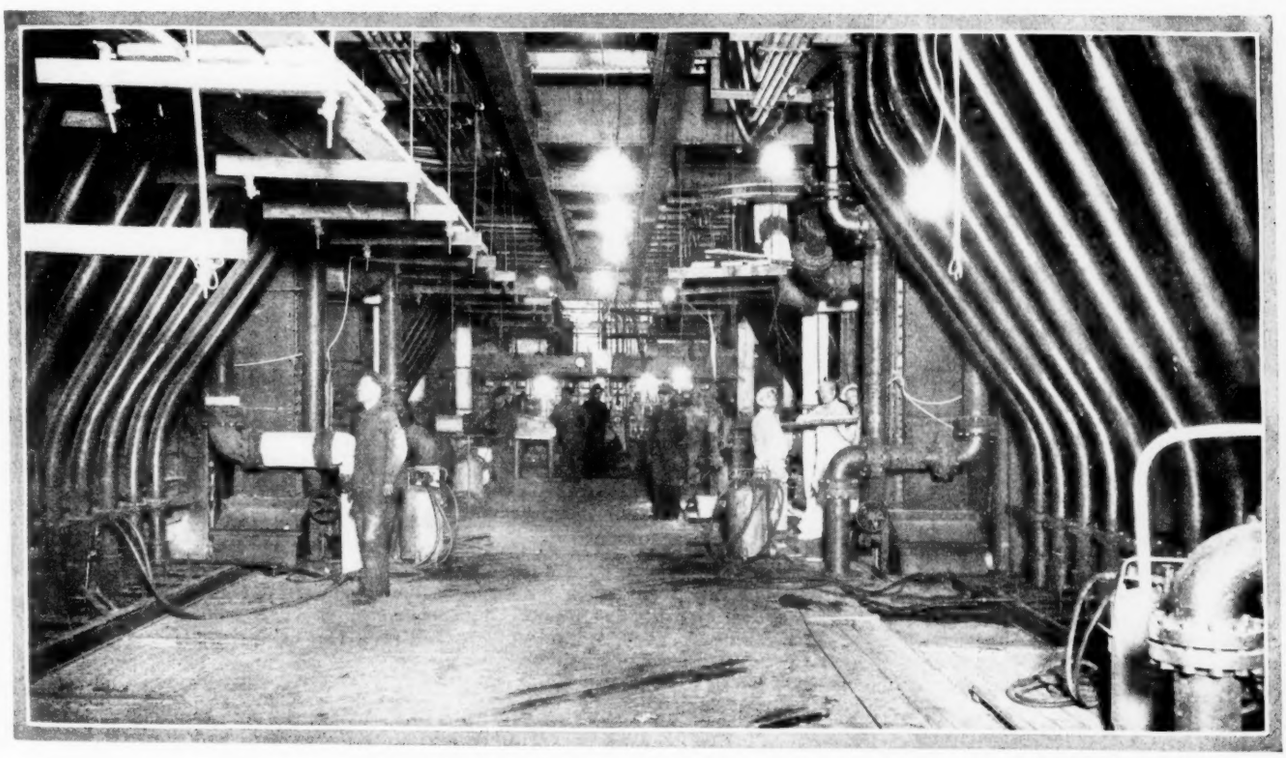


Boiler Plant



On the roof these huge dust collectors take out the fine dust from the flue gases and any cinder that may have passed the wet washers located below. The dust from these collectors is discharged to the ash sluicing system

Looking down the boiler aisle toward the "super-master" control board, by which the coal, air and water to all the boilers is maintained in proper proportions to meet load conditions. Each boiler is also provided with an individual panel by means of which it may be controlled separately if desired



Station Heat Balance

THE feed-water heating system of the station is as follows: The condensate from the main condensers passes through the air ejector condenser and aftercooler, and then successively through four closed heaters. The first is supplied with steam extracted from the 18th stage of the turbine; the second is supplied with steam from the auxiliary exhaust header; the third is supplied with steam from the 14th stage of the main turbine, and the fourth from the 11th stage of the main turbine.

At high loads the amount of steam from the auxiliaries may be more than the exhaust heater can condense. The excess steam is carried to the 18th-stage bleed line through a loaded valve and thence to the 18th-stage heater, resulting in a decrease in the amount of steam bled from the 18th stage. The pressure in the auxiliary exhaust heater varies with the load from about 10 in. vacuum at low to 2 lb. gage at the high loads.

The feed-water heating system is self-regulating The amount of steam bled from the various stages depends on the quantity of feed water passing through the heaters, inasmuch as each heater acts as a condenser for its steam.

Makeup water is introduced into the main condensers for the purpose of deaëration. It is estimated that it will amount to approximately 2 per cent of the steam produced.

The table shows the amount of steam absorbed in the heaters, the pressures and temperatures occurring at full load, 60,000 kw., for certain assumed auxiliary load conditions. It serves to illustrate the progressive heating of the feed water as it passes through the system.

Load Main Turbine	Heater	Lb. of Steam to Heaters	Steam Pres., Lb. per Sq. In. Absolute	Sat. Steam Temp.	Water Temp.
60,000 Kw.	Ejector Cond..	1,200	.6	85	80
	18th stage.....	29,540	5.0	163	158
	Aux. Ex.....	39,000	13.1	206	201
	14th stage.....	47,200	46.6	277	270
	11th stage.....	51,250	127.5	346	339

The hotwell pumps provide the necessary head for pumping the water from the hotwells through the ejector condenser and the first-stage heater into the second-stage heater; from the second-stage heater it enters the boiler feed pumps, which pump it through the third- and fourth-stage heaters into the boilers. The condensate from the stage heaters passes successively from the fourth down to the first, or lowest, pressure heaters, being trapped between stages, and from there pumped into the feed-water line between the first- and second-stage heaters. The condensate from the ejector condenser and aftercooler is returned to the main condenser.

There are no economizers on the boilers. They are, however, provided with plate-type air heaters, which raise the temperature of the air at normal rating, approximately, 390 deg., the escaping flue gases leaving at approximately 325 degrees.

Important Data and Ratios

East River Station of New York Edison Co.

Present capacity (March 15, 1927) two 60,000-kw. turbine-generators and one 40,000-kw. frequency changer set. Pulverized coal with bin and feeder system. All water-cooled furnaces of fin type. Steam and electric drive for auxiliaries. Thomas E. Murray, Inc., designing and constructing engineers.

Steam pressure.....375 lb. gage

Steam temperature.....700 deg. F.

Boilers installed.....6
(Boiler room laid out for ten)

Boilers per turbine.....3

Heating surface per boiler (exclusive of water walls and superheaters).....14,809 sq.ft.

Furnace volume above water screens.....15,888 cu.ft.

Furnace volume below water screens..... 4,969 cu.ft.

Furnace volume, total.....20,857 cu.ft.

Superheating surface per boiler..... 3,430 sq.ft.

Air preheating surface per boiler.....28,900 sq.ft.

Air preheating surface per sq.ft. boiler heating surface.....1.95 sq.ft.

Air preheating surface per cu.ft. furnace vol. (total).....1.39 sq.ft.

Furnace volume per kilowatt.....1.05 cu.ft.

Furnace volume per sq.ft. boiler heating surface.....1.41 cu.ft.

Furnace volume per sq.ft. stack area.....1,650 cu.ft.

Boiler heating surface per kilowatt.....0.74 sq.ft.

Superheating surface per sq.ft. of boiler heating surface.....0.23 sq.ft.

Forced-draft fans per boiler.....1

Forced-draft fan capacity per cu.ft. furnace volume (6.4-in. static pressure).....2.88 cu.ft. min.

Induced-draft fan capacity per sq.ft. stack area (8.5-in. static pressure).....3.95 cu.ft. min.

Number of driers.....3

Capacity of each drier exhauster fan....28,000 cu.ft. min.

Number of pulverizers.....6

Capacity of pulverizers, tons per hour.....15

Pulverizer drive.....250-hp. motors

Feeders per boiler.....10

Boilers per primary air blower.....2

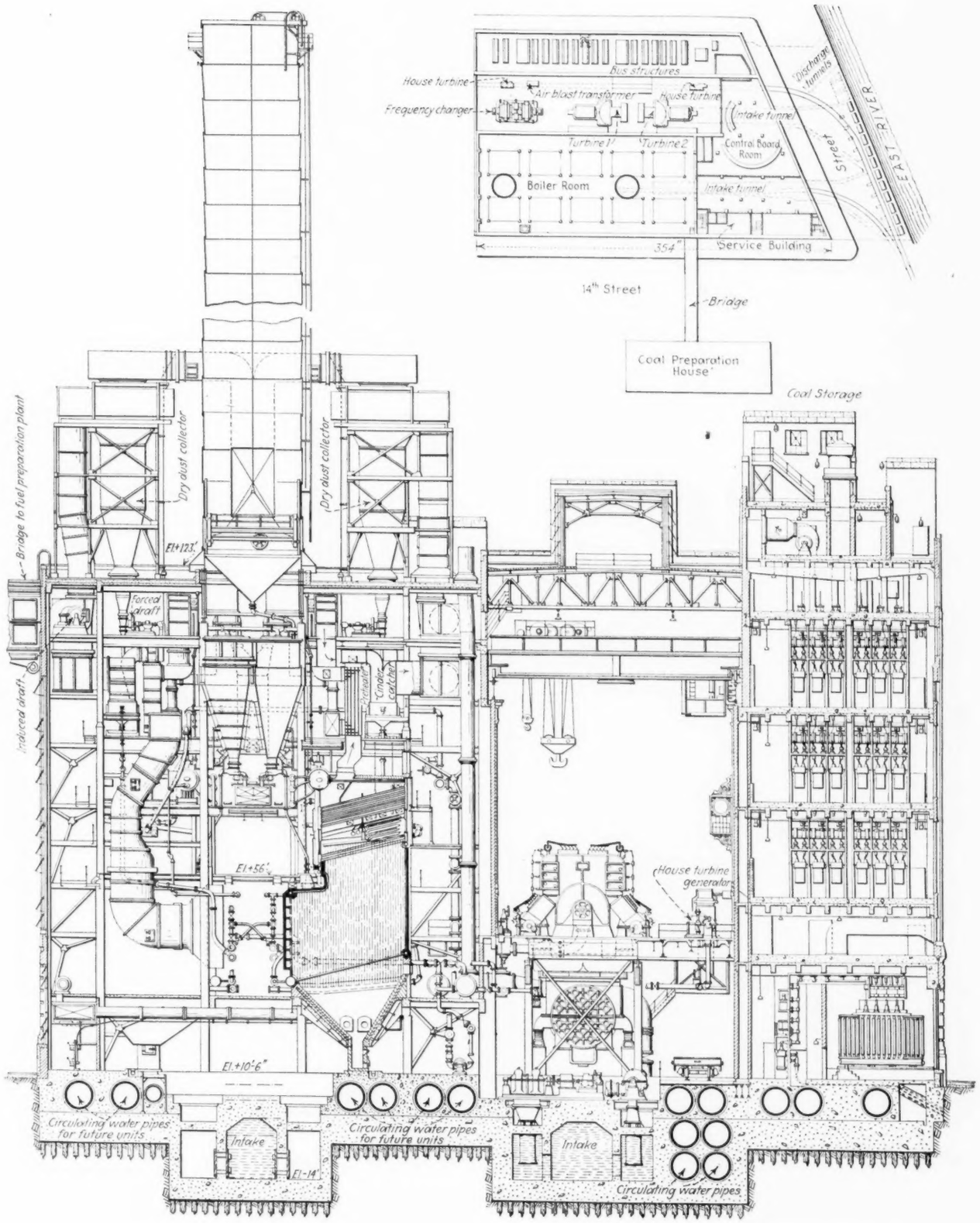
Generator cooling air per kilowatt.....1.83 cu.ft. min.

Auxiliary turbine-generators, direct-current....2 500-kw.

Auxiliary turbine-generators, alternating current (millhouse).....1 1,000-kw.

Exciters.....Shaft driven

Ratio exciter to main generator capacity.....1 to 300



Section through main building of East River Station and plan layout

How Push-Button Type Elevator Controllers Operate

By CHARLES A. ARMSTRONG

PUSH-BUTTON control for elevators has been adopted in a number of forms. In this article the operation of a constant-pressure push-button type and a two-floor automatic type are described.

ELEVATORS controlled from push buttons are coming into general use for many applications. One of the applications is where the car is used infrequently and it is not desired to keep an operator on it, such as in slow-speed freight service in certain classes of buildings with open-hoistway construction where the position of the car can be observed from the landings. Many of these installations were formerly hand-rope operated, and it always was a serious hazard reaching into the elevator hoistway to pull on the rope to bring the elevator to the floor and stop it. To meet the requirements of this service, a control has been developed known as the constant-pressure push-button type, which permits operation from either the floor landings or the car by push buttons. The push button must be held closed as long as it is desired for the car to stay in motion, and it is stopped by releasing the button. The control is what might be considered a car-switch type modified for the use of push buttons, to allow control from the landings as well as from the car.

Fig. 1 is a wiring diagram of a Westinghouse controller of the constant-pressure push-button type. This diagram is for a three-floor control, although any number of floors may be connected.

For the three-floor control there is an up- and a down-direction button in the car and likewise at the intermediate floor. At the bottom terminal landing there is a down-direction button, which will permit bringing the car to that floor by pushing the button. At the top terminal landing there is a button, which, when pressed, will bring the car to that floor. When there are more than three floors, at each intermediate floor there are two buttons, one to bring the car down and the other to bring it up, connected as indicated in Fig. 1.

Tracing out the circuits of the diagram will make clear the operation of the controller. The control circuit is from line L_1 through the contact of reverse-phase relay P to terminal O and to O on the push buttons. It will be seen that this wire runs to all the push buttons, so that if either an up- or a down-direction button is pressed, either the up- or the down-direction circuit will be made alive if the conditions of the circuit for safe operation are complied with.

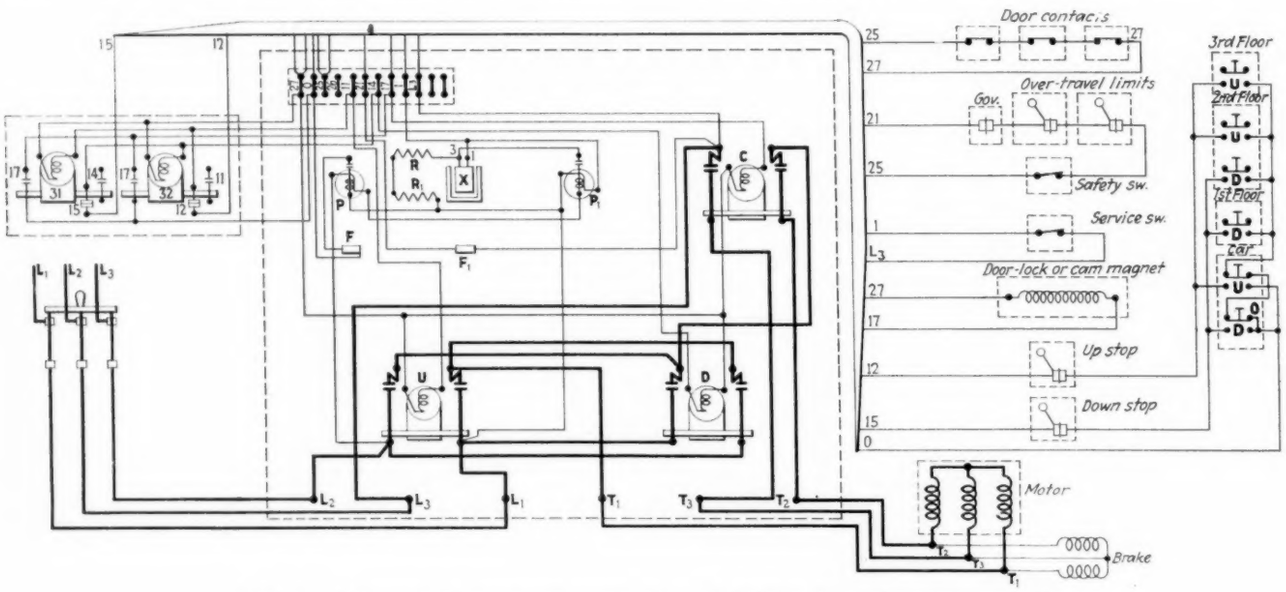


Fig. 1—Diagram of constant-pressure push-button type elevator controller

Assume that the bottom button D, which is the down button in the car, is pressed. This completes the circuit through the down stop switch to contact 15 on relay 31. This contact being closed, the circuit is to terminal 14, the down-direction switch coil D to terminal 27, through the door contacts back to terminal 25, then through the safety, overtravel-limit and governor switches to terminal 21 and the L_2 line. This energizes the down-direction switch coil and this contactor closes. At the same time that this operation has been going on, the coil of relay 32 is energized from contact 15, through coil 32 to terminal 27, through the door contacts and to the L_2 line as previously explained. From the foregoing

it is evident that unless the door contacts are closed, the direction-switch on the relay coil cannot be energized. The construction of the door locks is such that the doors must be closed and locked before the contacts can close. Therefore the car cannot be started before the doors are closed and locked.

Making the coil of relay 32 alive causes this relay to close. In doing so, it opens contact 12, which opens the up-direction switch coil circuit so that this switch cannot be closed by pushing an up-direction button while the down-direction button is held closed. When relay 32 closes, it makes contact 17, which completes the circuits for the door lock or cam magnets and for the line contactor coil *C*.

On some types of door locks there is a magnet coil in each lock. These magnets are connected to the lock mechanism in such a way that the doors cannot be opened as long as the magnets are energized. Even when the coils are not energized, the doors cannot be unlocked and opened except when the car is at the floor. A cam on the car holds up a lever on the lock that allows the door to be opened when the magnet in the lock is de-energized.

On another type of lock a magnet is put on the cam on the car, which raises the lock lever to allow the door to be opened. With this arrangement the magnet is used to pull the cam to a position where it cannot lift the lever on the locks when the car is in motion, and allow the doors to be opened. This also prevents a door from being opened unless the car is at the floor and the cam magnet de-energized, which means that the control circuits must be dead.

With relay 32 closed, the door-lock magnet coils are energized from *O* through contact 17, through these magnet coils to terminal 27 and to L_3 line, as previously explained. This completes the locking operation of the door at the floor where the car is standing. From 17 there is also a circuit through coil *C* of the line contactor to terminal 27 and to line L_3 as was traced for the direction-switch coil. With coil *C* made alive, this switch closes and the motor starts, the brake coils being made alive with the motor. The elevator will now keep in motion as long as button *D* is held closed. Releasing the button will stop the car, or if the button is held closed until the down terminal landing is reached, the down stop switch will be opened and the car stopped. If this switch fails, the overtravel-limit switches will be opened and interrupt all the control circuits.

The circuits just described would be made alive by pressing any one of the other down buttons. For example, pressing the second-floor down button the circuit would be from *O* through the down and the up buttons in the car and through the down button at the second floor and to the down stop switch. From here the circuits are as previously described.

For up direction, one of the up buttons is pressed, which energizes the circuits to start the car in this direction. These circuits may be traced in the same way as explained for the down direction. In this case it will be found that direction switch coil *U* will be energized instead of coil *D* and relay coil 31 will be made alive instead of coil 32.

Where the elevator has a lift of one floor only, such as for sidewalk service, the control, Fig. 1, can be arranged

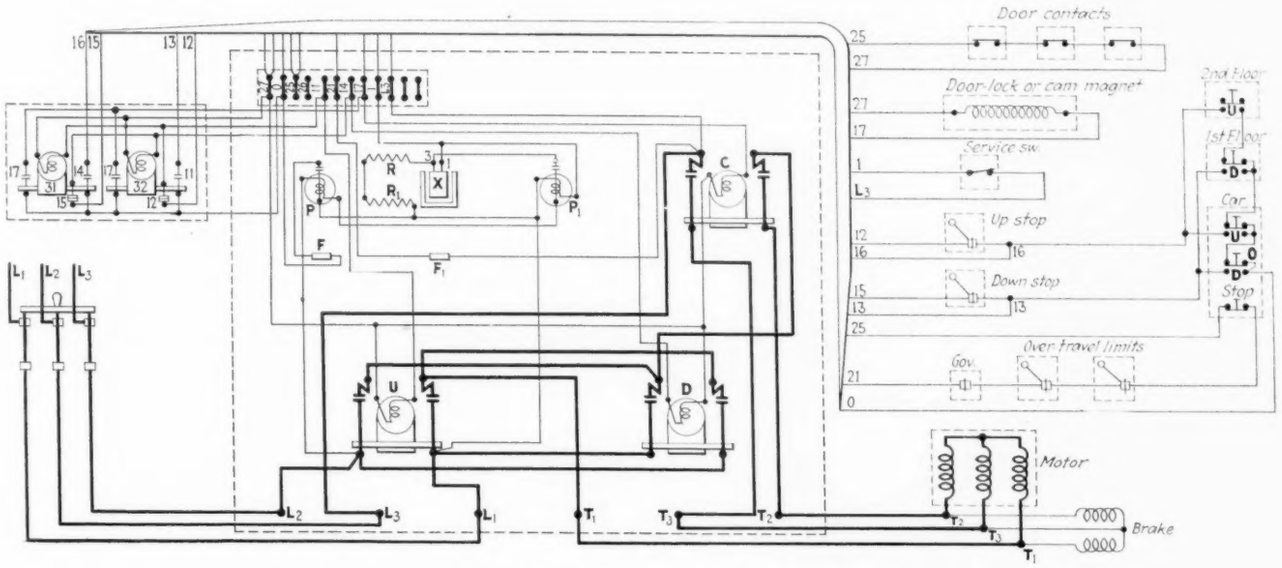


Fig. 2—Diagram of two-floor automatic push-button type elevator controller

so that the car will go to the floor after the button has been pressed and released. The diagram Fig. 2 shows the control Fig. 1 arranged for two-floor automatic operation. In these connections there are three buttons in the car, up *U*, down *D* and stop. This stop button, it will be seen, is in series with the overtravel-limit switches. When this button is pressed, it interrupts all the control circuits, the same as the overtravel limits do when they are opened. The purpose of the stop button is to allow stopping the car, by someone on it, before coming to the floor it was started for, should such occasion arise.

As there are only two floors, only one button is required at each. At the upper floor is the up button *U*, which, when pressed, will cause the car to come from the lower floor to the upper. Pressing the down button will bring the car from the upper floor to the lower. In Fig. 2, as in Fig. 1, the control circuit is from line L_1 to the down button *D* in the car. From this button the line continues to all the buttons. Assume that the car is at the upper floor and the down button is pressed. This completes the circuits through the down-stop switch,

through the down-direction switch coil *D*, and relay coil 32, as explained for Fig. 1. When relay 32 closes, it also completes the circuits for the cam or door-lock magnets and the line-switch coil *C* through contact 17, as in Fig. 1.

So far the operation of the controller is identical with Fig. 1. In Fig. 2, when relay 32 closes it makes a holding circuit through its contact 11. This circuit is from line *O* through contact 11 on relay 32 to 13 on the right of the down stop switch, then through this switch and will maintain the control circuits alive when button *D* in the car is released. Therefore, after relay 32 closes, the down button may be released and have the car go to the lower floor. On approaching this floor the down-stop switch is opened by a cam on the car and the machine is stopped with the car at the floor, if everything is working properly.

In the up direction the operation is the same as in the down, except circuits are established for up-direction switch coil *U* and the coil of relay 31, instead of coils *D* and 32. Where more than two floors are involved, floor selector switches and other refinements must be incorporated in the control system if it is to provide automatic control of the elevator. In many installations automatic push-button control is combined with a car-switch control. Such an arrangement is known as dual control. The car-switch control is used during periods of the day when traffic is heavy and warrants putting an operator on the car. When the traffic is light the automatic push-button control is used and the machine operated by those using the elevator.

Catching Heat on Its Way to Waste

BY J. LEWIS

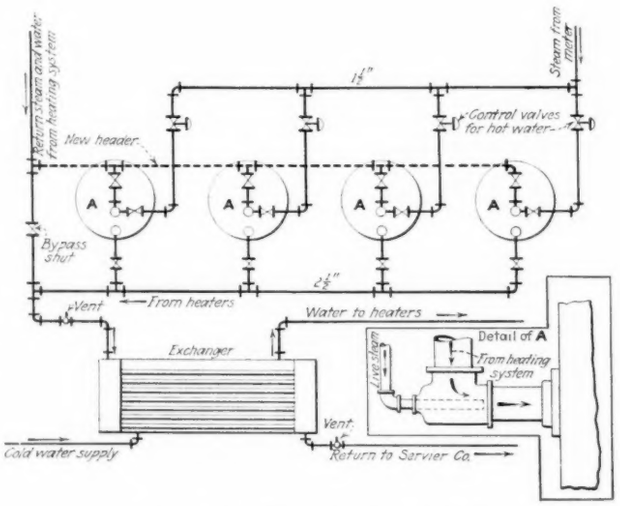
Excessive steam waste, in a 15-story apartment building that covered an entire city block, called for prompt attention and remedy. The steam supply was from a central station through meters. The condensate was returned through a meter and the quantity credited, but not the temperature. It was therefore desirable to reduce the temperature by utilizing as much of the heat of the condensate as possible. The return from the heating system and water-heating tanks was, therefore, passed through heat exchangers, virtually surface condensers, through which the incoming service water passed to the water-heating tanks. The steam for heating the water for the house use came through a separate reducing valve and meter. This meter registered over $20 worth of steam used per day for heating water alone. The recording thermometer on the return water showed 212 deg. F. and sometimes more when the pumps were on.

Furthermore, the 2-in. atmospheric vent pipe through the roof was blowing steam "full bore" because of numerous defective thermostatic valves throughout the building. It was difficult to get access to the various apartments and to get at each individual valve because, naturally, tenants paying fifteen to twenty thousand dollars a year did not want a lot of repair men messing up their quarters in search of blowing thermostatic valves. They were not interested in saving B.t.u. or dollars for the owner so long as their comfort was served.

The foregoing "stage setting" is necessary to the story of how the waste was stopped, at a small cost and no inconvenience to the tenants.

A new 6-in. header, an extension of the return line, was run along in front of the four water-heating tanks and connected, through valves, to the steam supply opening to the heating coils within the tanks, as shown in the illustration.

The regular steam supply was also reconnected, beyond the valve on the return line, through the reduced run end of a tee placed horizontal and into the center opening of which the returns emptied. In this way the thermostatically controlled live steam did not retard the travel of the return water, steam and air from the heating system. A swing check valve on the



How the coils were reconnected

heating-system return line prevented the water-heating steam from backing up into the heating system when there was no heat on and the hand valve was left open. The atmospheric vents for the heating system were taken off from points beyond the water-heating tanks.

The results were gratifying. No steam could be seen escaping from the vent. The temperature of the return water dropped to about 135 to 140 deg., and the steam meter reading on the water-heating line dropped to less than $5 a day during the heating season. No new equipment was used except the necessary pipe and fittings. The total cost of the job, including material and labor, was just under $800. This arrangement has been in use several seasons and there is no worry about leaky radiator valves.

TO CLEAN AN INJECTOR, if the parts are not readily separated on account of corrosion, submerge it in kerosene for a few hours. Remove the tubes from the body of the injector and cleanse them of any grease by washing in a strong solution of potash and water and, after washing in clean hot water, dip the parts in a solution of 1 part of muriatic acid to 10 parts water, but only for a long enough time to soften the scale, after which the tubes should be washed in clean water to stop the corrosive action of the acid. After the tubes have been cleaned nearly down to the finished surfaces with any convenient tool, complete the cleaning with a scraper made of hard wood so as not to mar the original surfaces or change the form or dimensions of the tubes. Spots or patches of scale not readily removed should be softened by local applications of the acid solution, taking care after each application to wash the tube clean.

Forestalling Trouble by an Annual Inspection of Steam Turbines

Coupling Alignment and Wear—Axial and Radial Clearance—Adjustment of Reaction Machines—Blading Defects—Cleaning the Oil System and Bearings—Adjusting the Governing Mechanism—Valve and Shaft Packing

THE steam turbine requires special care if successful operation is to be guaranteed. Its advantages of high efficiency and high speed are purchased at the expense of small clearances and high stresses. The recommendation of manufacturers that their turbines in service be subjected to a thorough inspection at about yearly intervals should therefore be strictly followed by the purchaser. This interval is usually a convenient one for the power plant because there is often some seasonal slack period that fits in with such a regularly recurring inspection. In a few special cases where operating conditions are severe or abnormal, more frequent complete or partial inspection may be desirable.

This inspection may be considered as having a threefold purpose. In the first place, it is necessary for safety and economy that worn parts be replaced Second, replacements, not immediately necessary, can be ordered at leisure to have on hand when the turbine is again opened up. Third, conditions may indicate that a change in oil, or gland sealing water, etc., is necessary.

All emphasis is on a thorough examination. The tendency, in general, is probably to make a too cursory examination. The manufacturer is usually willing to furnish a man to aid in the inspection if the operator feels the expense is justified.

Alignment Should Be Checked

The coupling alignment of all units should be checked immediately after the machine has been shut down, since, especially with large units, the shaft deflects after it has been standing a few hours.

With a flexible coupling, if the shafts are parallel, opposite points on the faces or ends of the coupling halves will maintain their separation distance constant in all positions as the coupling halves, still fastened to their respective shafts, are turned through one revolution together. In order to determine this separation distance, the bolted-up, outer portion of the coupling must be removed.

If the shafts are also in line, a straight-edge, resting on the edge of the bigger of the two couplings, in case there is a slight difference in the diameters, will clear the edge of the smaller coupling by a constant margin as the coupling halves are revolved together. Of course, if the couplings are of exactly the same size, this clearance will be zero and the straight-edge will rest evenly on the two coupling edges as the shafts and coupling ends revolve.

Unless misalignment is indicated by the foregoing or by excessive coupling wear, it is not necessary to check the alignment of all the main bearings if the machine is smaller than, say 10,000 kw. On larger machines, however, this bearing alignment should be checked after the spindle and generator rotor have been removed.

Axial and Radial Clearances

If possible, the clearances of a turbine should be checked with the machine hot. With the machine cold the contraction resulting will change these, so it is desirable to have them adjusted for operating conditions.

In most turbines endwise movement of the rotor is made possible by shifting the thrust bearing through the medium of a worm gear or a screw connection of some kind. If there is such provision, the axial adjustment can be made with the turbine hot and running at

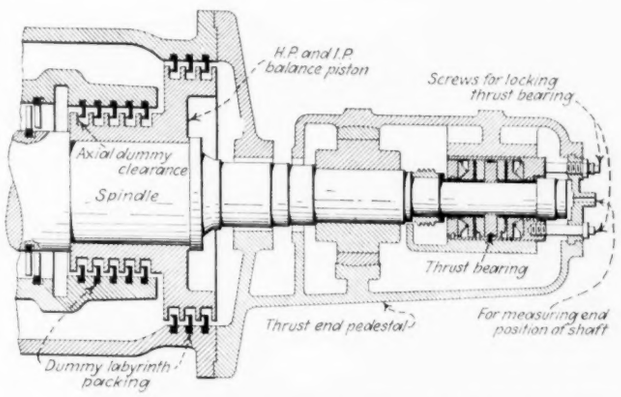


Fig. 1—With axial clearance packing on dummy piston of reaction turbine, the spindle is adjusted endwise to give proper clearance at this packing

reduced speed, say 10 per cent of normal. In order to determine the range of axial movement possible, the rotor is carefully moved in one direction until rubbing is detected with the aid of a listening rod of hard wood or steel, one end of which is held on the casing and the other end near the observer's ear. The position of the spindle can then be either read on a dial provided or measured directly between the end of the shaft and a fixed part of the casing. Then the rotor can be backed off axially until it rubs in the opposite direction, and the corresponding readings taken. This must be carefully done, as this rubbing is unnatural and might seriously damage the stationary packing strips.

On other turbines, as in Fig. 1, there is simply a provision for locking the thrust bearing in position and, when this bearing is freed, the rotor must be moved endwise with the aid of a bar at the coupling. The limit of axial travel is found by forcing the rotor

to the limit of its movement in each direction and taking the corresponding readings. By doing this immediately upon shutting down the machine, hot clearances can be found.

The position in which the rotor is set after determining the axial movement depends on the turbine construction. If a labyrinth packing is provided of the axial clearance type, either on the shaft or on the dummy pistons of reaction turbines, the minimum clearances occur here and the manufacturer will specify the clearance from one extreme rubbing position. Thus, in Fig. 1, the shaft is moved to the right until it rubs and then backed to the left an amount equal to the axial dummy clearance.

In case packing of this axial clearance type is not used, but a water seal is provided, the clearance between the impeller on the shaft and its casing will determine the limits of motion endwise. Fig. 2 shows the position of the impeller in its casing in a typical

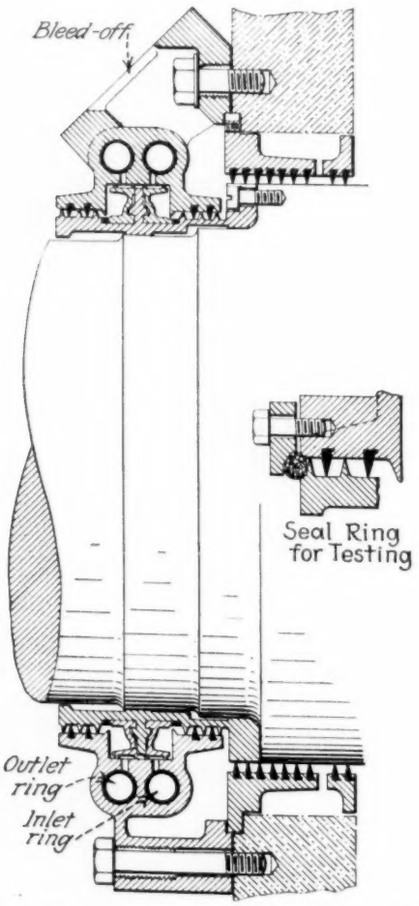


Fig. 2—The impeller of a water seal should be centrally located in its casing

case. Under such conditions the rotor should be adjusted to the center of its travel, giving equal clearances on both sides of the impeller.

If none of the foregoing small axial clearances exists, but rather the minimum clearance is between the moving and stationary blades, axial adjustment is not so essential because such clearances are relatively large.

In any case, if the axial movement is considerably less than normal, a careful investigation should be made when the turbine is later opened up.

With the reaction type of turbine there is usually only a small clearance radially between the blades and the casing to reduce tip leakage. This radial clearance should also be checked. The total vertical movement and the final adjustment of the spindle to the central position or a little above can be brought about by adjustment of liners under the main bearings. The side clearance should also be checked.

Blading Should Be Inspected

The inside of the turbine should be very carefully inspected. In order to do this, the top half of the casing and the rotor must be removed.

The blading should be inspected for defects and for

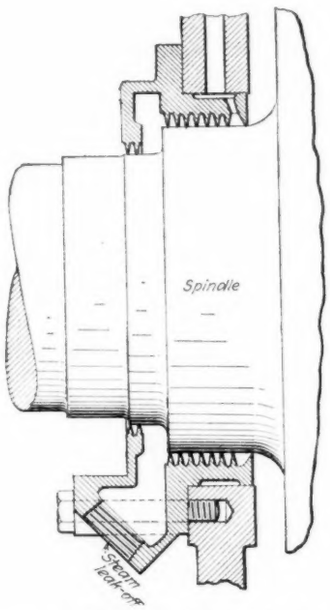


Fig. 3—Wear or mutilation of labyrinth shaft packing is evidenced by excessive leak-off at high pressure end

the accumulation of dirt or scale. Corrosion or erosion may have worn the blades in the middle or later stages. In some cases the accumulation of scale has been so serious as practically to close up the steam passages through the blading. If this condition exists, it should be remedied if possible by some change in feed-water source or treatment.

The stationary nozzles in the casing should also be inspected. With the impulse type of turbine the condition of the diaphragm packing at the shaft should be looked over to see that it is not mutilated.

Oil System and Main Bearings

The oil pump, cooler and lines should be dismantled. One should look for dirt, choking up due to emulsification, or corrosion.

If the lines are choked up or corroded, or if there is an excessive deposit on the tubes of the oil cooler that would tend to reduce the rate of heat transfer, a different oil should be specified. If it is necessary to clean the pipes, this can be done with compressed air or steam.

If a collar type of thrust bearing is used, its bearing surfaces should be inspected for wear.

The main bearing surfaces and oil grooves should also be cleaned and checked. Even good oil will deposit some solid material, and it must be left to the judgment of the operator as to whether the deposit and wear

are enough to justify a change in the kind of oil used.

In case the throttle valve mechanism and safety trip are oil operated, the oil lines leading to these parts as well as the oil relay and trip mechanism themselves should be gone over and cleaned.

Governing Mechanism and Throttle Valves

The governing mechanism should be checked for lost motion in pins, levers, etc. The knife-edges should also be examined to see that dirt has not caused excessive wear and thus changed the sensitiveness of the governor. If there was, initially, an adjustment of the limits of motion of various portions of the mechanism, these should have been noted and should be checked during the inspection.

All steam and oil packing around the main valves as well as around the auxiliary valves of the mechanism should be replaced. The cost, at this time, of such replacement is low and it should guarantee more continuous service. After repacking, it should be seen that there is no undue friction present. In case the throttle

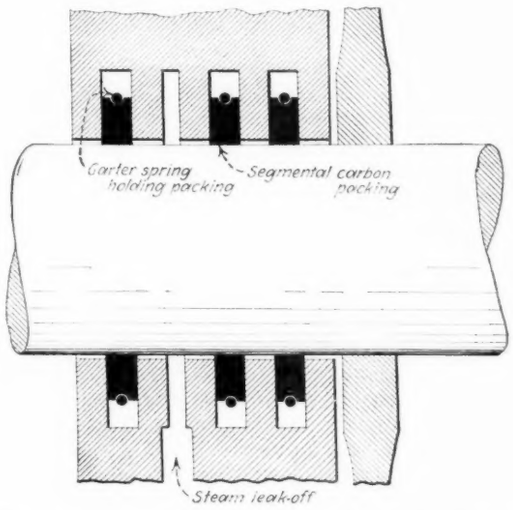


Fig. 4—Worn carbon packing also has excessive steam leak-off

valves show any signs of cutting, they should be reground to their seats. This trouble will probably be apparent before the unit is torn down, because the leaking steam will keep the turbine hot when not in service.

If the governor is driven by a worm from the mainshaft, this worm and wormwheel should be examined. Particularly see that the thrust bearing for this governor shaft has not worn sufficiently to lower the vertical shaft and so bring the gears out of line.

The emergency overspeed governor should be gone over to see that it is in good mechanical shape, free from undue wear, accumulations of sediment, etc. Its functioning is usually tested at periodic intervals, but in some plants it is customary to remove the assembly from the turbine at the period of annual inspection, and test it by driving it to its tripping speed in a lathe or special set-up, with a reliable tachometer to indicate the precise tripping speed.

Shaft Packing

If the shaft packing is of the labyrinth type, without a water seal and with or without a steam seal, evidences of trouble will be apparent while the unit is in operation. This shows up at the high-pressure end by an abnormal leakage of steam through the leakoff or into the room and at the low-pressure end of a condensing turbine by the whistle of air into the exhaust casing if no steam seal is used or, if a steam seal is used, an excessive requirement of sealing steam. This is evident from the construction indicated in Fig. 3, showing a labyrinth shaft packing without steam or water seals.

The same thing is true if carbon packing is used as seen in Fig. 4. If the carbon packing is worn, the segments may be shortened by filing, in case the wear is not too great, and the fit around the shaft will again wear in tight. However, in case of excessive wear the segments will have to be shortened materially and rebored so that the inner surface will wear in correctly.

If a water seal or a steam seal is used, the runners or casings provided must be inspected for scale. If such a deposit is extensive with water seals, the source of the water should be changed if possible. Condensate is frequently employed for this purpose. It is essential that this sealing water be of a very high grade. With steam seals, if there is a scale formation, there is probably also a scale formation on the blading and nozzles, and a change in the source of the feed water or its treatment is desirable as already stated.

Insulation Resistance as a Guide to Motor Conditions

By J. L. Rylander*

IT IS often desirable to know the condition of the insulation of electrical motors before starting them up, as breakdowns sometimes occur which destroy the winding and which would not have happened had the winding been dried out or cleaned. Windings absorb moisture and accumulate dust. If too much moisture is absorbed or if too much highly conducting dust accumulates on the winding, insulation failure occurs. It is therefore desirable, if possible, to know the condition of the insulation.

There is no sure way of absolutely determining the condition of insulation, but an approximate indication of it can be made by using insulation resistance measurements. However, the insulation resistance values must be used with a considerable degree of intelligence, as insulation resistance itself is extremely variable and the type of insulation has to be taken into consideration.

How Temperature and Moisture Affect Insulation

Figs. 1 and 2 give an idea of how insulation resistance may vary, owing to temperature and moisture. The size of the machine and the voltage rating have also to be taken into consideration, as shown by the A.I.E.E. standards formula for the minimum insulation resistance in megohms for a machine at its operating temperature, which is,

$$\frac{\textit{Voltage at terminals}}{\textit{Rated capacity in kva.} + 1{,}000}$$

As the insulation resistance is taken from the conductor to the iron core, the main slot insulation almost entirely determines the value obtained. It is, therefore, evident that the insulation resistance does not neces-

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sarily indicate the condition of the insulation between turns in the coil. If the type of insulation is such that moisture enters or can be driven out without much difficulty, the insulation resistance value will indicate the condition of the turn insulation inside the coil as well as the condition of the slot insulation; otherwise it will not.

Insulation resistance should not be confused with dielectric strength. Insulation resistance determines only the current-conducting quality of the insulation, which has no definite relation to its dielectric strength, which is its ability to resist puncture by applying voltage.

As Fig. 2 shows, moisture has a great effect on the insulation resistance, therefore it indicates that such measurements should be useful in many cases if all other variables can be eliminated or taken into consideration. If insulation resistance measurements are taken at intervals of three to six months on a particular motor at the same temperature each time, the comparative values will indicate any change in the condition of insulation. That is, a knowledge of the insulation resistance is useful when it can be compared to other values whereby such variables as size, voltage, rating, kind of insulation and temperature are eliminated.

Determining Resistance Values

As has been mentioned, insulation resistance values vary greatly. Nevertheless, the following will give an idea of what to expect: New, clean and dry motors up to 100-hp. rating for 550 volts or less at 20 deg. C. will usually have 50 to 100 megohms in induction-motor primaries; 50 to 100 megohms in the field of direct-

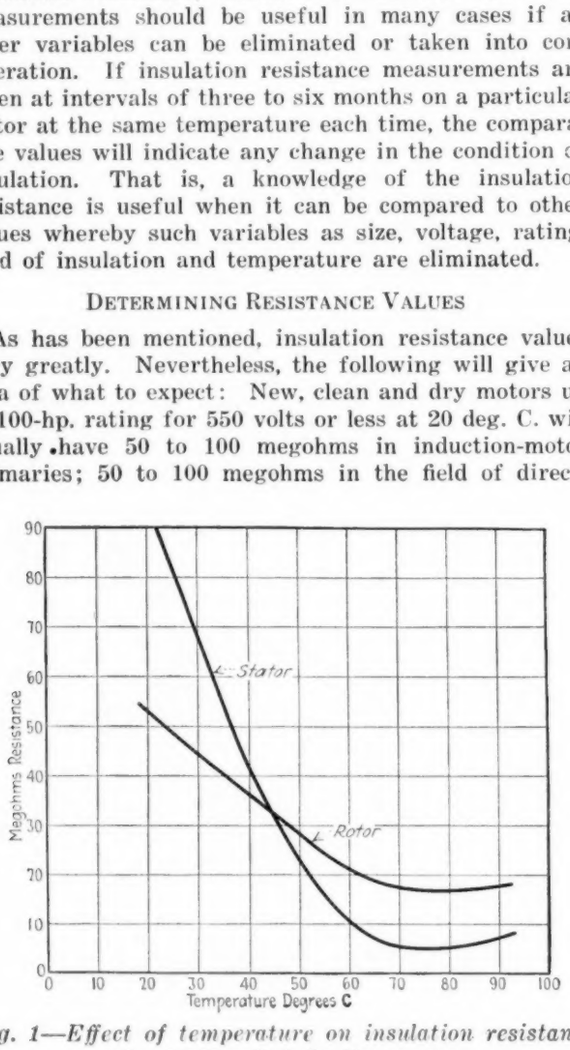


Fig. 1—Effect of temperature on insulation resistance of a 4,000-volt induction motor

current motors; 1 to 5 megohms in direct-current armatures.

The A.I.E.E. standardization rules state that the insulation resistance of a machine at its operating temperature should be not less than that given by the following formula:

$$\text{Insulation resistance in megohms} = \frac{\text{Rated voltage}}{\text{Rating in kva.} + 1{,}000}$$

Insulation resistance may be measured with a megger or a Wheatstone bridge or by means of a high-resistance voltmeter.

Insulation resistance measurements are sometimes used to determine the condition of insulation, when it is suspected that conditions exist that may cause breakdown when the motor is put in operation. It may be that a motor has stood idle for a long period in a damp atmosphere or has been immersed in water due to

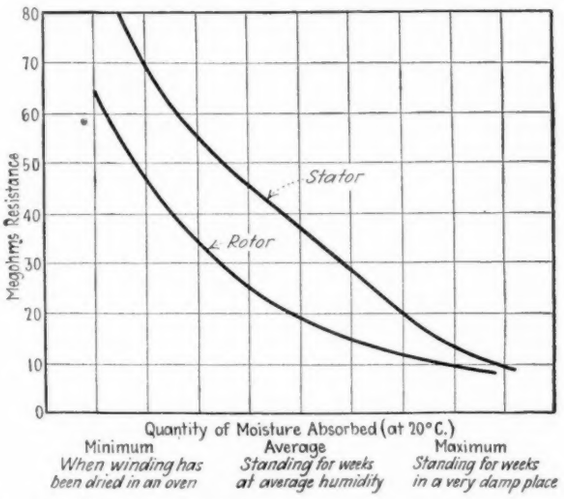


Fig. 2—Effects of moisture on insulation resistance of a 4,000-volt induction motor

various conditions and attempts made to dry it out, and it is desired to know whether it has been actually dried out. There may also be an excess accumulation of carbon dust from the brushes which becomes embedded in the insulation and is difficult to remove. Some operators who have no unusual operating conditions, desire to check at intervals of three to six months whether any general deterioration can be noticed. Insurance companies for electrical apparatus use insulation resistance measurements for determining the condition of the equipment.

Insulation resistance measurements will determine the condition of the insulation provided the various factors are duly taken into consideration. The insulation resistance value alone does not indicate whether the condition of the insulation is satisfactory. For example, a large motor failed when its insulation resistance was 4 megohms, and a water-soaked 230-volt armature in a direct-current machine, and a 220-volt induction motor operated with an insulation resistance of 20,000 ohms. The type of insulation was the determining factor in these cases. The large machine that failed had accumulated moisture through a long period of idleness, and the insulation was for a high voltage and such that the moisture could not be expelled readily; the insulation for the low-voltage motors was such that the moisture was easily expelled as well as having ground insulation that was adequate for the rated voltage even when this was temporarily water-soaked. Therefore, all factors must be taken into consideration with the use of the insulation resistance readings.

While insulation resistance measurements do not determine the quality and reliability of the insulation used, they are useful and desirable in determining the conditions of the motor insulation with respect to cleanliness and dryness.

Freeing Carbonized Piston Rings

By A. B. Newell

THE removal of pistons for the purpose of cleaning and freeing rings is a part of the routine work of maintaining internal-combustion engines. When this is done it is not uncommon to find one or two and sometimes more of the upper rings stuck fast in the grooves as the result of carbon formations. On almost every occasion such as this, the engineer feels that he would like to save the rings for use again, since having them stick seldom causes them to break. In addition, being inactive for some time has prevented them from wearing as much as the other rings, which have been doing most of the work.

To avoid having rings stick is, of course, a lubricating and combustion problem, provided that they have been correctly fitted, but almost everyone who has had extensive experience in oil-engine operation has found at one time or another, upon opening up the engine, combustion has gone bad or lubricating oil has been applied too freely, causing some rings to stick tight.

Saving the Rings

The common procedure, in an attempt to save such rings, is to use some thin hardwood blocks and a hammer and, after giving them a soaking with kerosene, to tap and pull and pry. Perhaps one end of the ring comes free and a screwdriver or some other blunt instrument is inserted as a pry, a bit too much pressure is applied along with an extra heavy tap, and the ring breaks. A cape chisel and hammer are next employed with considerable care to avoid damaging the ring groove, and the ring is removed in fragments. Then the groove is cleaned up and a new ring is fitted. If apparently more successful, the ring may be removed intact and put back in service only to prove that, because of too much pulling and hauling, it has been sprung out of shape and no longer functions as it should, since it does not fit the cylinder wall or does not move freely in the groove. After a few such experiences as this the engineer decides that it is a waste of time to attempt to save the rings and breaks them out at once.

Boiling in Lye Water

On one large engine we were conducting extensive experiments with the fuel-atomizing device and deliberately inviting a brief period of combustion troubles. During the experiment we managed to stick about forty rings, which represented an investment of $16 each, or $640. It was worth while to devise a means of saving them if possible. We therefore rigged up a vat in which the pistons could be immersed and filled it with a strong solution of lye water in which we boiled the pistons for six hours. Thereafter we removed all the rings without springing or breaking one and put them all back in service. The lye had no appreciable effect upon the cast iron, but it removed all the grease and oil and much of the carbon.

Subsequent developments led me to wonder whether the heat alone would not have done the trick. One or two of the pistons were left to cool over night before cleaning off the carbon, and the next morning we found that the carbon deposits had again hardened.

Later, on another engine, we had some difficulty in removing the exhaust valves after they had been in service about three months. A carbon deposit would form between the valve cage and the cylinder head in the clearance space, and although the valves were in good condition when removed, we found that it paid to remove them before the carbon deposits had formed in sufficient quantity to make them very difficult to remove. If not, we spent more time with their removal than would be consumed normally in removal and overhauling.

Pulling the Exhaust Valves While the Engine Is Hot

Having in mind the piston-ring experience, I decided to try pulling the exhaust valves while the engine was still hot; that is, immediately after closing down and before the engine had time to cool. The experiment was successful. It was quite evident that heat was keeping the carbon in a semi-plastic and weakened state, so that the valves could be removed easily.

Further evidence of this occurred in a plant that I visited some time later. The engines were of the two-stroke-cycle type and had been running fairly well for a long time. One day they were shut down and allowed to cool whereupon it was found impossible to start them again. A subsequent investigation revealed the exhaust pipe and expansion chamber plugged up solid with carbon. The thing that mystified the engineers and everyone concerned was how this engine could run with the pipe so clogged. Obviously, it had not been doing anything of the sort. The pipe was clear while the engine ran or else it would not run. Owing to poor combustion or over-lubrication or both a considerable amount of black tar-like substance was escaping at the exhaust ports of the engine and going out through the exhaust pipe. A heavy coating of this substance formed on the inside of the pipe while the combustion chamber and portion of the pipe down near the engine became almost clogged up with carbon deposits. The heat of the exhaust was keeping all this in a semi-fluid state and maintaining a passage through it as the result of the velocity of the outrushing gases. When the engine was stopped, however, this substance ran down the pipe and closed the remaining passage, and then, when it cooled, it hardened to the general characteristics of what is commonly called carbon, although it was heavy in oil content.

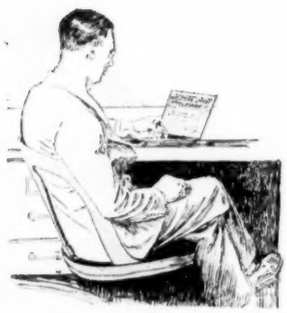
Carbon Not the Only Trouble Maker

As a result of these various experiences and observations I have come to the conclusion that the word carbon covers a multitude of residual substances, some of which are entirely capable of being softened and removed with the moderate application of heat.

As far as the problem of removing stuck rings is concerned, it is doubtful whether it would pay to rig up a vat and cook the pistons in order to clear them. It is far better to keep close tabs on combustion and lubrication so as to prevent them from sticking. However, it offers a means of saving them when it is necessary to so do, as for example, when more rings are stuck than the number of spares on hand and it would be necessary to wait until new rings could be made or obtained from the engine builder. Of course it will do no good in cases of piston seizure where the rings are "froze" in the groove and partly fused metal is wiped over them.

When Purchasing Coal, the Small Utility Has Its Troubles

By N. D. P. IRISH



OFFHAND it would seem that the problem of buying coal for the rural utility would be very similar to buying fuel for any other kind of public-service corporation—the physical limitations of unloading and handling might not compare, but the ability to obtain an adequate supply should be about the same in either case. This is not always true. Our system load requires a yearly supply of bituminous coal of, roughly, fifteen thousand tons. This is a small fuel item when compared to the requirements of any large metropolitan system. In fact, the tonnage is so infinitesimal that, offhand, the matter of getting it would appear to be no problem at all. The actual placing of a contract with any reliable operator is nothing more than signing the order for the year's estimated requirements. But after the contract is signed, its carrying out is quite another story.

Not so many years ago this system was a small isolated rural unit. Fuel was purchased on the spot market under a hand-to-mouth buying program. Being a youthful organization, our financial resources were quite limited, for which reason we could not afford to tie up much money in stored coal. In the event of a prolonged interruption to our supply the plant would cease to operate. Since the load was small and did not vary much from year to year, we assumed that we dare take the risk.

Tying Up with Neighboring Utilities

In the course of time it became evident that it would be good policy to tie up with one of the neighboring utilities. This plan was carried out and in a few years, instead of one there were three interconnections. The adjoining companies were so situated that after all of them were hooked up, our station became the hub of which the connecting lines to the other systems were the spokes.

Starting with the day these properties were linked to ours, the storing of fuel became a different matter altogether. It was impossible to forecast accurately the probable coal requirements a year in advance. No one knew just how much current would flow over the tie lines into our territory. What complicates the problem for us in trying to estimate future coal needs is the water-power resources of our neighbors, two out of three of the interconnected companies having hydroelectric developments as well as steam. To further muddle the situation, one of hydro-steam properties has a group of storage reservoirs above the water-power stations, whereas the other system has practically no means of storing the spring and fall floods. The larger of the two has its hydro plants on rivers that are subject to sudden rises, the plants of the other are on streams with a more even annual flow. Even the spring thaws do not occur at the same time on the two watersheds.

Each year, about the first of February, the system operator of one of the adjacent properties will advise us that he is in a position to quote us a price that is a shade over one-half of our coal cost per kilowatt-hour. At this low rate there is only one thing to do, and that is shut down the turbines and bank the boilers. Banking coal increases the kilowatt-hour cost of purchased power slightly, but not sufficient to prevent its being a good buy.

Hydro Service an Uncertain Quantity

No prediction is ever made as to how long the water power will last or when there may be a change in price. Buying what is known as dump, or "slop," power is a day-by-day transaction. This kind of power is rarely sold on contracts, it is too uncertain. It is simply a case of grab it when there is an available surplus. Some time during the early spring, when the winter snows have been light, there may result only a few weeks of low-cost current. On the other hand, during years when the winter precipitation has been heavy, the amount of low-rate hydro power during the spring may last for several months. What has just been said applies to whatever territory receives the spring breakup first.

While this low-cost power is merrily flowing into our substation, cars of soft coal are all the while piling up on our siding. As rapidly as we are able, we unload the coal and view with alarm the rapidly diminishing storage area. It may sound paradoxical to make the assertion that we look with apprehension upon the slowly increasing coal piles. Here is the reason. The storeyard will hold, at the outside, only thirty-five hundred tons of soft coal. When the space is filled, all coal shipments must stop.

Monthly Shipments Interrupted

When the mine operator signs the year's contract, he does so with the understanding that our annual coal requirements will be taken care of by his shipping to us approximately equal monthly allotments. By keeping down peaks in mining coal his costs per ton are reduced. Naturally, he does not relish the idea of having the spring coal we should have taken, left on his hands. This would quite likely be a period when distress coal would be hard to sell. Right here we get in bad with the coal operator. If we make a practice of holding up the spring shipments due us each year, it is not long before the word is passed around that any contract we sign is of little value to the mine owner. With the stockpiles full of coal we finally have to wire the mines to hold up until further notice. Our pre-

dicament is explained to the firm selling us coal, but whatever we can say does not help matters very much. Anyway, the coal stops coming in. For the time being our fuel troubles are dormant; only one thought comes up to plague us in the meantime, and that is will we be able to get coal when we request the mine to resume shipment?

The April Coal Market

April first arrives, and if our coal contract is still alive, we may wire for a few cars as a feeler. The pile is not low, but wisdom tells us it is better to have a few cars rolling in case of emergency. If the mine is hungry for business, the car numbers are sent on with dispatch. For the other extreme, due to lack of orders, the operation supplying the grade of coal we use may be shut down. In this event a substitute fuel from some other mine must be accepted. This is invariably a poorer grade than the contract specified. Since the fault is all our own, we must take what is sent and say nothing about it, for we know that April first is, as a rule, a poor time to go into the market for fuel.

This was forcibly brought to the writer's attention by the following quotation from a letter recently sent in by a large coal-selling agency. Here it is: "Are you aware of the fact that April 1, the date set for the bituminous strike, is just one month off? What have you done to protect yourself against this situation?" We receive an average of one letter a day in this vein whenever a coal strike is in prospect. The sales theory back of this kind of approach is one that is beyond me. It looks like trying to scare us into buying. They use the threat of shortage to make us stock up, and incidentally, if enough get frightened, cause a runaway market. Letters of this kind, to say the least, are irritating.

Why is so much of the sales effort expended in pushing soft coal based on the fear complex? Is it always necessary to threaten a tie up at the mines to stimulate sales? Not any of us will buy coal if we do not need it. Applying the same methods to other lines of business, does this follow?

Passing down Main Street in the home town, does Abie Levenstein dash out on the sidewalk and pull me into his store? Will he try to frighten me into buying a new suit of clothes by saying there will be no more wool after the first of the month, the sheep are going on a strike? Not on your life. He is too wise and has been too long in the selling game to waste his efforts in such an illogical method of approach. Knowing me fairly well, he brings out the kind of suit that I like and explains the extra value there is in it for so low a price. He practices diplomacy and makes the operation of taking my money as nearly painless as possible.

Was it not Cotton Mather, the illustrious New England divine, who, during Puritan times, frightened the elect into repentance by preaching hell fire? His methods produced results in the days of our forefathers. Would they in these times? Can the soft-coal salesman, using such obsolete methods hope to accomplish anything permanent today? It would seem doubtful.

At Very Low Speeds the power capacity of any locomotive will permit enormous tractive forces to be developed, so that the real limitation of the maximum tractive force is the adhesion weight on the drivers.—*Mechanical Engineering.*

Points in Gas-Engine Operation

By W. E. Warner

In the operation of a gas plant a considerable number of faults may develop. One of these is the binding of the gudgeon pin in the small end brasses. This is due to the pin's wearing oval as it is quite likely to after being in service a considerable length of time. This can be avoided by giving the pin a quarter turn every time the piston is drawn, equalizing the wear all around the pin. Binding may or may not have objectionable results.

A knock may occur on the compression stroke due to the piston rings' having worn a ridge in the liner. If a new top piston ring is put in or the big ends taken up, the top piston ring may strike this ridge with a resulting knock. The ridge must be removed by a smooth file and the liner wall polished by means of a round lap.

A knock once occurred on a medium-sized gas engine which could not be traced to any of the usual causes. After some time the cause was detected by accident, and it became necessary to remove the flywheel key, which was found to have been fitted very badly, as it was high in the middle and low at the back and front, only a small area was effective in holding the flywheel to the shaft. When the keyway was trued up and the key was properly fitted, the knock disappeared.

In an 80-hp. gas engine a serious heating of one of the big ends started. Increasing the clearance and the lubricant had no effect, and it became impossible to run with more than three-quarter load without the risk of the big end burning out. Someone suggested that the flywheel might be out of balance and this might cause the heating. The flywheel was tested and being found to be considerably out, the balance was corrected by means of balance weights. When the engine was started, it was found that the offending big-end bearing ran quite cool, and it ever afterward proved satisfactory.

As a general rule, if a knock develops, the engine should be shut down immediately and its cause investigated. The knock may simply be a preignition knock, but is likely to be something more serious. If the hydrogen content of producer gas is increased, a preignition knock will probably result if the compression is high as it would be if designed for a gas ordinarily low in hydrogen. Excess of hydrogen may be easily developed owing to careless or inexperienced handling of the producer. The different zones of the producer fuel bed should be maintained at their correct depth. Weak gas may be caused by a bad condition of the fires or by air leaks into the top of the producer. In the latter case combustion will probably proceed in the producer top with a resultant overheating.

To obtain good results from a gas plant, it is necessary to have an attendant who knows how to temper it, particularly if using low-grade fuels, but given intelligent management, a gas plant will usually give good results.

Are You Trying for the *Power* prize? It affords a good opportunity to tell others what you have accomplished, with the added incentive of a chance to win one of the prizes to be awarded to those who show the best results of their ingenuity. Don't forget that the small plant is as good a field for such efforts as the big one.

New Heating Plant for St. Mary's Hospital

By CARL F. LAMBERT*

ST. MARY'S HOSPITAL, Kansas City, Mo., has just completed the construction of a new heating plant and laundry. The present hospital has about 250 rooms and a large chapel. Plans are in progress for the construction of a new 100-room nurses' home, and some time in the future the capacity of the hospital will be doubled.

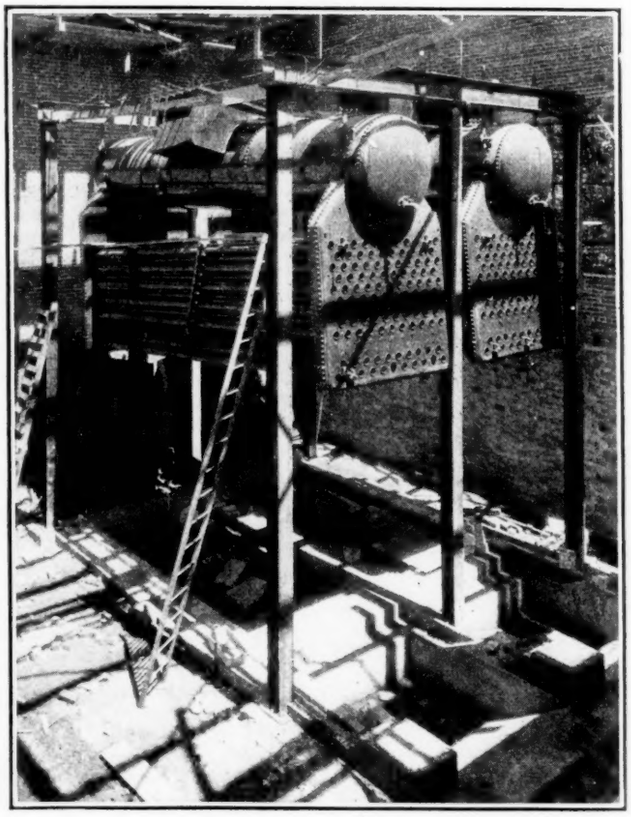
The immediate problem was not only to provide for the heating of the present hospital and the new nurses' home, but also to provide space for additional capacity to take care of the future extensions.

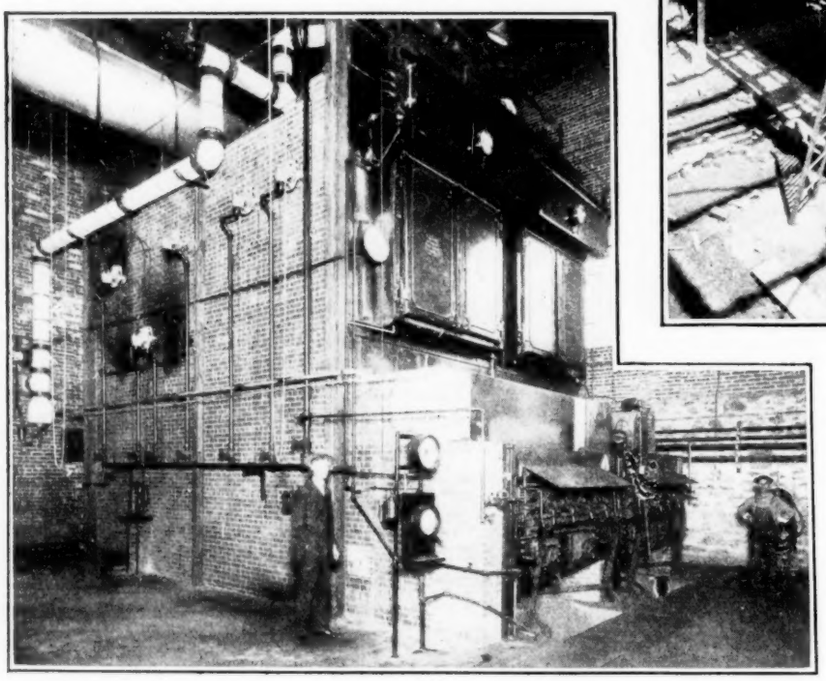
The boilers consist of two units of 2,120 sq.ft. each, and space is provided for one more unit of like capacity. They are built for 200 lb. working pressure, so that turbine-generators can later be installed if desired. At present steam is generated at 125 lb. gage pressure, and electrical energy is purchased.

The floor of the boiler room is about 11 ft. below the ground level. This makes possible the location of a coal-storage space on the boiler-room floor level, with a roof over which trucks can be driven from the street level, dumping directly into the storage room. There is no railroad switch adjacent. The storage has a capacity of about 100 tons. Ashes will be removed by a steam-jet ash conveyor to a hopper outside the building, from which they will be loaded into trucks or wagons.

The water-tube boilers are set 11 ft. from floor to bottom of tubes. They are fitted with overfeed stokers arranged for hand or power operation. Soot blowers and flow meters are installed. The brick stack is 5 ft. in diameter and 125 ft. high.

The refrigerating machinery is in the "engine room," ample space being provided for the future installation of generating equipment and the necessary auxiliaries.





Above—The water-tube boilers were set 11 ft. from floor to bottom of tubes

Left — Completed installation. Note flow meter, soot blowers and stokers

Pipes and wiring are carried through a tunnel to the hospital, and another tunnel has been constructed to the site of the nurses' home. These are of reinforced concrete 6x7 ft. inside.

The plant was designed by Burns & McDonnell Engineering Company, consulting engineers, of Kansas City, Mo., and Los Angeles, Calif.

*Burns & McDonnell Engineering Company.

Power Consumption of Ammonia Compressors

Theoretical Power Requirements—Actual Indicated Horsepower—Input Horsepower—Horsepower Charts

By W. H. MOTZ*

OPERATING engineers are vitally interested in the power consumption of all mechanical equipment under their supervision. Since the power cost is an important item in the manufacturing cost of the product, it is advisable to keep the main compressors in good operating condition and to determine the actual power consumption of each unit. The amount of power used may then be compared to that obtained in other plants where best results are being produced, or if such records are not available to the individual engineer, he should determine, from the conditions in his plant, just about what the power consumption of various units should be and then make his comparisons and analysis.

Methods of Checking Power Consumption

There are various methods of checking up power consumptions of ammonia compressors. The best method, of course, is the direct measurement of the quantities at the desired points in the system by means of suitable indicators, meters and the like. In many cases, however, there is a lack of sufficient facilities for measuring the power consumption directly, so that the engineer cannot accurately determine the amount absorbed by each unit.

In studying the compression of ammonia vapor, the problem is simplified by assuming that there is no loss or gain of heat, as heat during compression. In other words, it will be assumed that the compression is adiabatic. As a matter of fact, under actual operating conditions in the compressor the actual compression approaches closely to the adiabatic. This is especially true of the medium- and high-speed compressors operating on slightly superheated ammonia at the suction.

So long as the condenser pressure is above the evaporator pressure, it is evident that work must be used to compress the ammonia vapor from the pressure in the evaporator to the pressure in the condenser. Now, when the compression is adiabatic, it is evident also that the work of mechanical compression appears in the compressed gas as heat.

The higher pressure and temperature of the gas after the actual compression shows the validity of this statement, without going into the thermodynamics of the case.

Interconvertibility of Heat and Work

Another law of thermodynamics states that heat and work are mutually interconvertible, in the ratio of 778 ft.-lb. being always equivalent to 1 B.t.u. In other words, one horsepower (33,000 ft.-lb. per min.) is equivalent to expenditure of heat at the rate of 42.42 B.t.u. per min.

*Technical engineer, Hill Manufacturing Co., Chicago, Ill.

The theoretical horsepower for compression may be obtained from the fact that the heat equivalent of the mechanical work of compression is equal to the difference of heat contents of the ammonia before and after compression. The author's formula for the theoretical indicated horsepower of ammonia compressor per ton of refrigeration is:

$$I.hp. = 4.712 \frac{(H_2 - H_1)}{(H_1 - h_1)}$$

where

H_2 = Heat content of a pound of ammonia gas after compression in B.t.u. per lb.;

H_1 = Heat content of the ammonia gas before compression;

h_1 = Heat of the liquid just before the expansion valve.

For standard conditions of 5 deg. evaporating temperature and 86 deg. condensing temperature, the following values for the foregoing quantities may be obtained from the ammonia tables:

$H_2 = 712.9$ $H_1 = 613.3$ $h_1 = 138.9$

The theoretical horsepower is found:

$$I.hp. = 4.712 \frac{(712.9 - 613.3)}{613.3 - 138.9} = 0.989$$

The foregoing is based on the assumption that there is no superheating of the suction gas at the compressor and that there is no aftercooling of the liquid ammonia below its condensing temperature.

How the Theoretical Power Requirements May Be Calculated

In a similar manner the theoretical power requirements may be calculated for any evaporating or condensing temperature. Having obtained the theoretical power requirements in this manner, the actual indicated horsepower may be obtained from the theoretical by dividing by the volumetric efficiency, thus:

$$Actual\ i.hp. = \frac{i.hp.}{vol.\ eff.}$$

This relation holds true in compressors where the clearance is small. The brake horsepower is obtained in the usual manner; that is, the actual brake horsepower is obtained by dividing the actual indicated horsepower by the mechanical efficiency, or

$$B.hp. = \frac{a.i.hp.}{mech.\ eff.}$$

The input power is the power taken from the electric power lines in the case of a motor drive, or it is the indicated horsepower of a steam engine in the case of steam-engine drive. In other words, the actual total power consumption of the ammonia compressor should include the losses of prime mover due to the friction,

windage, etc. The actual input horsepower is obtained from the actual indicated horsepower of the compressor, by dividing by the combined mechanical efficiency of the compressor and its prime mover, thus:

$$Input\ hp. = \frac{a.i.hp.}{combined\ mech.\ eff.}$$

The actual combined efficiency of the compressor and its prime mover depends upon a number of factors, such as workmanship on compressor parts, design of parts, relative size of machine and the like. In a medium-sized compressor and its prime mover the mechanical efficiency will be about 83 per cent.

The volumetric efficiency of the ammonia compressor depends upon a number of factors, such as suction pressure, condenser pressure, type of compressor and the like. Reliable tests made by prominent manufacturers afford data on this subject.

Calculating Input Horsepower

Assuming that the volumetric efficiency of a compressor operating under standard conditions is 83.4 per cent and that the combined mechanical efficiency of the compressor and its prime mover is 83 per cent, input horsepower may be calculated from the theoretical indicated horsepower as follows:

$$A.i.hp. = \frac{0.989}{0.834} = 1.186$$

$$Input\ hp. = \frac{1.186}{0.83} = 1.42$$

The author has pursued the foregoing methods in calculating the data shown in Fig. 1. This chart gives the input horsepower per ton of refrigeration for single-acting compressors. The lower horizontal scale gives the input horsepower per ton of refrigeration. The vertical scale on the left gives the condensing temperature and pressure. The curves in Fig. 1 are for constant evaporating pressure and are plotted for even 5-deg.

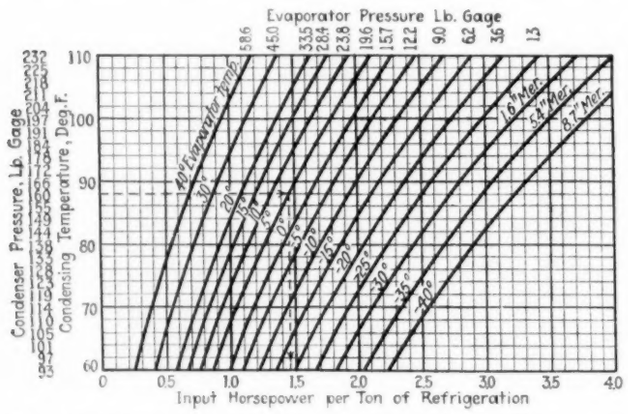


Fig. 1—Power consumption of single-acting compressors

temperature differentials, with corresponding pressures. The dotted lines show the method of reading the chart.

Fig. 2 gives the equivalent data for double-acting compressors. The corresponding input power in kilowatts may be obtained by multiplying the input horsepower by the constant 0.746, thus:

$$Input\ kw. = input\ hp. \times 0.746$$

The foregoing data refer only to the power consumption of the main compressors. Additional allowance must be made for power consumption of auxiliary equipment.

The data given on the subject of power consumption show not only the total compressor input power consumption, but also the effect of a change in condensing or evaporating temperature. Figs. 1 and 2 show, graphically, why it is desirable to keep the condenser pressure as low as possible and the evaporating pressure as high as possible. The saving in power consumption due to improvement in the plant or in the operation,

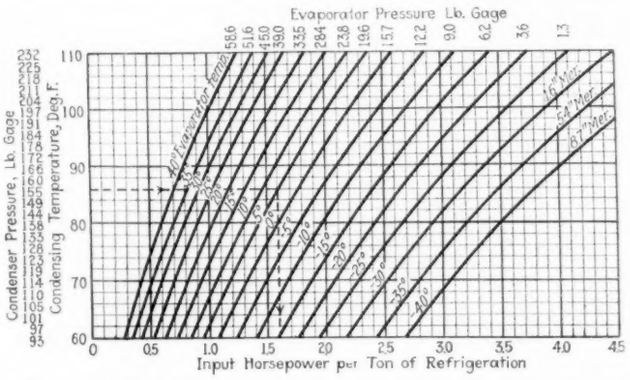


Fig. 2—Power consumption of double-acting compressors

resulting in lower condenser pressure or higher evaporating, may be estimated directly from Figs. 1 and 2. The savings in power costs over a given period of time may then be determined from the cost per unit of power.

High Pressure At Sea

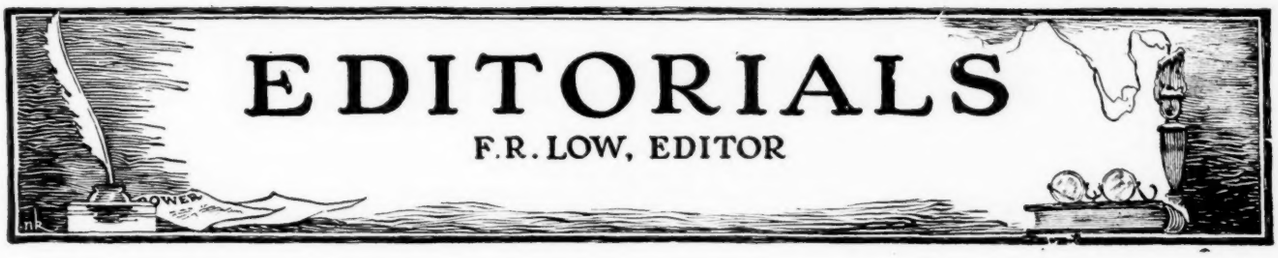
Those familiar with the great economies obtained ashore today with high-pressure steam plants will no doubt wonder why such installations have not been tried afloat. Such an installation would make an interesting and probably valuable comparison with a similar ship fitted with Diesel engines.

The first so-called high-pressure installations were actually used afloat, but the advantages of such pressures became so obvious that they were adopted by shore stations, which soon surpassed the marine practice. However, there is every indication that marine practice will soon adopt higher pressures, although the steps must perforce be slow.

There has recently been completed abroad a Channel steamer using 500 lb. steam pressure and 750 deg. F. total steam temperature. This marks the first very high-pressure steam installation on board ship. Detailed results of the trials of this ship are not available.

American shipowners are not far behind. The Southern Pacific Steamship Co. has already laid down a ship using 350 lb. steam pressure and 250 deg. superheat, or a total temperature of 688 deg. F. It is anticipated that this ship, which will have 6,250 s.hp., will operate at the rate of 0.75 lb. of oil per s.hp. The Bradley Transportation Co. has just placed an order for a ship to have 325 lb. steam pressure and 281 deg. superheat, which equals 710 deg. F. total temperature. This ship will also have a modern stoker installation.

Considerable effort is being expended in experiments with pulverized fuel. If pulverized coal can be practically applied at sea, satisfactory fuel economy can be obtained and at the same time the drain on our oil resources will be lessened. The successful application of pulverized coal will provide another advantage in favor of the high-pressure marine steam plant.—*Mechanical Engineering.*



New Solutions for Old Problems

THE design of the East River Station of the New York Edison Company displays several new lines of attack for old problems.

Much that is most conspicuous in the design of this plant is to be laid at the feet of the unknown genius who made the original street layout for Manhattan Island. With a block of land two hundred by one thousand feet, lying perpendicular to the water front, the task of the plant designer is far from easy. It is unfortunate that the city fathers could not have seen their way clear to closing Fourteenth Street for one block, so as to give the engineers a more workable plot and obviate the necessity of splitting the plant into two buildings connected only by a bridge.

However, the solution of some of the resulting difficulties may point the way to interesting possibilities in plants not so circumscribed geographically.

The location of circulating pumps remote from their condensers is not new, for there are plants with remote pumphouses, but for a compact station the arrangement seems different from any yet proposed. With steam-driven pumps the economy of steam piping is obvious. Further, the simplification of operating control and the opening up of the usually crowded space around the feet of the turbine bases is an advantage.

Placing generator air coolers above the turbine-room floor gives the machines a strange appearance and involves the problem of protecting the generators against slugs of water condensed from the air stream in the coolers, but these difficulties are offset by the elimination of the difficult task of designing a turbine base that shall be structurally effective and yet give ready access to the coolers for cleaning and repair. The layout should give heart to those who wish to install closed-circuit cooling on generators in existing plants.

The extensive use of automatic control for combustion and other important functions is significant, perhaps, of what might be called a trend in modern power-plant operation.

Perhaps the most interesting thing about the plant, from the point of view of the industrial plant owner and operator, is the employment of steam-driven auxiliaries. Calculations indicated that the station economy was about the same with motor-driven auxiliaries and with steam drive for the larger units, even with some of them operated by condensing turbines. If turbine drive, with only partial utilization of the exhaust steam for useful heating, can compete with motors in a power plant where the cost of electric energy must be well below one cent per kilowatt-hour, how much stronger must be the case for a well-designed and well-operated industrial plant in which there is a reasonable balance between the need for heating steam and for power.

Hydro-Electric Units Without Governors

ONE of the largest items of cost in operating a hydro-electric plant is interest on invested capital. It is but natural, therefore, that methods of keeping this charge down should receive careful thought. Recently, the possibilities of leaving the speed governor off waterwheels have attracted considerable attention as a means of keeping down the cost of a project. There are some arguments for doing this, at least under certain conditions. On interconnected systems in many plants where governors have been provided, the units are operated at a fixed gate opening, part or all of the time without governor control.

According to a recent report made by the N.E.L.A. Hydraulic-Power Committee, on one large system the governing is done by about two and one-half per cent of the capacity connected to the system. This arrangement may work satisfactorily where the load is fairly constant, but it cannot be done where the load fluctuates widely. It appears to be the general opinion that fifty per cent or more of the connected capacity should be under governor control. This, however, is influenced by a wide range of conditions. One very important one is the system frequency, which must be kept within fairly close limits. An undesirable condition would exist if a large plant operating on a system, should become isolated without sufficient load to keep it under control.

Even where part of the load is not connected to the plant, if it becomes isolated from the rest of the system, it is not desirable to have the units out of control, on account of the time required to get them back into service if for no other reason. If only part of the units in a plant are equipped with governors, the others are available for use when they can be controlled by the load, which will probably be most of the time; but it is possible for emergency conditions to exist where the useful capacity of the station might be seriously handicapped because some of the machines lacked governors.

The cost of hydraulic equipment in a plant will vary between about five and twenty per cent of that for the project, depending on the type of development. The governing equipment will average about five to ten per cent of this cost. Therefore, probably in no case will the governor represent more than one per cent of the total cost of the project. All of this cannot be saved by leaving off the governor, as means must be provided for hand control of the water to the unit.

There are conditions where other savings, such as the cost of a surge tank, a reduction in the cost of penstocks and pipe lines, come into the problem. In some cases, under these conditions, it has been found economical to eliminate the governor and provide other means of controlling the waterwheels. But these are special cases and do not represent general practice.

Cost of construction is not always a criterion of the most economic design of plants, since a unit out of control may cause damage that will cost more to repair than governors could be purchased for. It would be a rather expensive experiment to repair the damage and have to purchase the governors besides. Experience with operating plants designed without governors is rather limited, and it will be prudent to go carefully in such undertakings until more is known about them.

Economics Will Give the Final Answer

IN A certain sense the central station and the isolated plant are natural competitors. As is often the case where competition is keen, there has been some tendency for each party to look with suspicion upon the words and actions of the other. The central-station men feel that owners of isolated plants are sometimes too slow to close them down because of overconservatism and an unwillingness to scrap machinery that is still capable of years of satisfactory operation. They feel that not enough weight is given to such factors as value of space occupied by engines, release of managerial talent for strictly manufacturing problems and failure of power and process loads to synchronize.

The operators of isolated plants, on the other hand, claim that the owners are subjected to high-pressure salesmanship which few have the engineering knowledge to resist, that there is a tendency to make improper fixed charges on the operation of the isolated plant, and that power rates are too low in comparison with other rates.

To the charge that power rates quoted by the utilities are below the cost of production, it can be said that there is a limit within which this practice is perfectly sound business and good economics, and another limit beyond which it is certain not to be done, at least not permanently. In the doubtful ground lying between these limits there is much material for fruitless argument.

Those who feel no call to assume a partisan rôle in this discussion, preferring to look at the whole matter in the broader light of sound economics, can see some signs of improving relations. While many individual cases seem to prove the contrary, there is undoubtedly a trend toward agreement on a middle ground. Those who formerly advocated the isolated plant as always and everywhere superior have at last been forced by the logic of events to admit that there are many circumstances under which it is better and cheaper to buy power.

On the other hand, the slogan "the isolated plant must go," which had become almost axiomatic with some enthusiastic utility salesmen, is giving way to more temperate programs. There *is* such a thing as overselling power. In almost every community there are loads that are not worth while for the utility if they must be obtained on a competitive basis, and others that can unquestionably be carried at lower cost by a combined power and heating plant. There will continue to be such, because growing efficiency of generation and distribution by the utilities will be paralleled by better design and operation in industrial plants. Incidentally, there is more room for improvement in the latter.

The broader-gage operators of private plants are now generally reconciled to the possibility of going over to purchased power if this can be proved cheaper, although they will properly continue to demand a fair trial and an honest analysis.

On the other side some of the largest and best-engineered utilities are feeling the moral influence of straight engineering thinking and willingly refrain from trying to shut down plants that can operate with *genuine* economy.

There are still differences, but the day is coming when competing engineers can sit down calmly and discuss this matter in the cold light of economics. In the long run this will be best for all concerned. Neither the utilities nor the operating engineers can afford to work against the best interests of industry as a whole.

Steel Foundry Practice

STEAM pressures in new power plants have been increasing steadily for several years, and undoubtedly still higher pressures will be employed in future plants. The use of such pressures, coupled with high steam temperatures, has resulted in the more extensive use of steel castings for such parts as valve bodies, pipe fittings, turbine casings and boiler specialties.

One hears occasional complaints about the poor quality of steel-foundry practice in this country. Several castings must be poured to get one that will not have to be rejected on account of blowholes, spongy spots or other causes. These rejections increase the cost of the delivered castings. Many of these faults are not apparent until much of the machine work has been performed. Then welding methods are employed to patch up the faults if this is possible. In some cases pinholes do not show up until the part has been in actual service for some time. While patched castings are often used, they are never as strong or reliable as good sound first-class castings. It is sometimes difficult to assign definite causes for these failures in the foundry.

The net result is increased cost of steel castings and encouragement toward designs that use forgings in place of castings.

In view of this would not a full and comprehensive investigation of steel-foundry methods and practice be warranted? The foundries and the users might undertake this work in their joint interests. Such a study should cover foundry methods and labor, various casting procedures, types of molds, the use of different steels for castings, the value of alloys in producing sound castings, methods of examining and testing newly made castings to detect flaws or blowholes (for example the X-ray or magnetic methods) and methods of annealing and seasoning castings. Such a comprehensive program would involve a large expenditure, but the benefits to be derived in lower power-house costs would soon repay the cost of the research.

The Power Prize

HELPING you to help yourself is the business of *Power*, and now there is a further step in the shape of offering a prize to those most successful in availing themselves of this help. For articles submitted before May 15, 1927, showing the most commendable improvements in the results obtained from the modernization, reorganization or improved operation of a power plant during the last two years, *Power* offers prizes of $500, $250 and $100.

Come after yours!

Ideas From Practical Men

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted.

Transformer Bushings Broken Due to Faulty Installation

Cracks in the porcelain of transformer bushings are often due to solid busbars being rigidly connected to the terminals of bushings. Busbar copper may easily be subjected to a range in temperature from —10 to 110 deg. F., or a 120 deg. range, which means an eighth of an inch linear expansion for every ten feet of busbar. A range of 150 deg. is common in some localities, with a three-sixteenth expansion for every ten feet of bus.

If a busbar betwen two bushings or between rigid connections to the station framework is straight, an expansion of one-eighth inch would crack the porcelains. If, on the other hand, the busbars are not straight, calculations will show whether or not the included bends of such heavy material will relieve the bushings from the strain. Copper tubing, either straight or curved, has the same characteristics as solid bars, and with a few companies it is standard practice to include a short flexible section in any such busbar connection to relieve strain from bushings.

GUY BARTLETT,
General Electric Company.
Schenectady, N. Y.

Removing Piston Rings

For removing and replacing piston rings, the tool shown in the illustrations will prove of great value both in speeding the work and in preventing damage to the rings and the edges of the ring grooves.

The tool is made with two handles like a pair of pliers

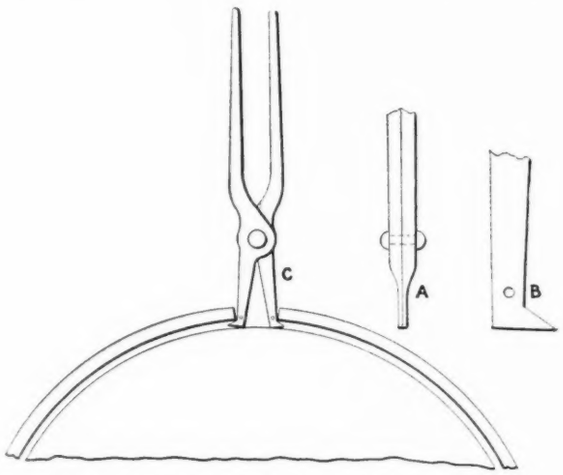


Fig. 1—Tool to Remove Piston Rings

or pincers, only these handles are not crossed at the pivot. Thus the jaws open when the handles are closed instead of closing like pliers.

The ends of the jaws are drawn or ground thin and left so the two points lie close together, so they may be easily pushed between the ends of the ring when the tool is turned edgewise. It is then turned as shown at *C* in Fig. 1, and the handles are compressed, spreading the ring so that it may be easily pushed from the groove in the piston.

At the end of each jaw is a hole that will admit the

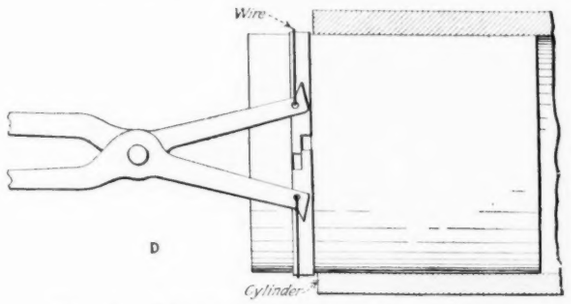


Fig. 2—Slipping Rings into the Cylinder

end of a common stovepipe wire easily. In replacing the piston in the cylinder, the expansion of the ring prevents it from entering until it is compressed around into the groove. A piece of stovepipe wire is placed through each of the holes in the ends of the jaws of the tool, as in Fig. 2, and the loop of wire placed around the outside of the ring. Then the ends are bent over after pulling it through to the proper size.

North Bend, Neb. GEORGE MCVICKERS.

Removing a Pump Liner

I was all dressed up one day and had no special place to go, so I dropped around to see an old friend of mine who was engineer for a once famous brewery. Of course that was in the good old days when breweries were in flower. It was a hot day in summer, and my friend always brought me around to a rack full of mugs adjacent to a cool keg of beer.

On this occasion I found my friend Fritz in the boiler room sweating over a pump repair he was making. The pump needed a new liner and he was taking out the old one. Fritz was tugging away at the old liner, which was probably ¾ in. thick, with a comical rig of bolts, washers and packing blocks. Once in a while a block would slip, and away went all his hard labor of rigging up. After watching him about ten minutes, I said to him, "Let me show you how to take that out."

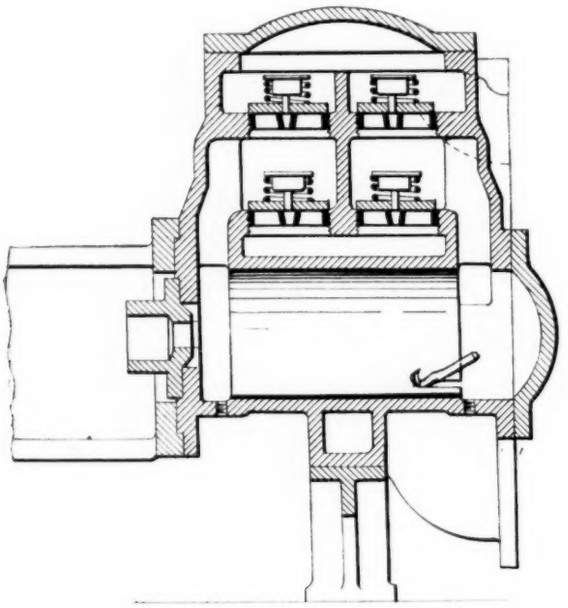
He was quite willing to let me get mussed up for the fun of it.

All I wanted was a cape chisel, a chisel bar about two feet long, and a heavy hammer. Fritz lost no time in getting these out of the engine room for me, and then went out to slacken his thirst. When he returned, the old liner was on the floor, the new liner was in, and I was sitting on a box with a prohibition-agent expres-

sion on my face. All Fritz could say was, "How did you do it?"

After I told him, he said, "Come out and have a drink," which was what I came after in the first place.

The pump liner was removed in the following manner: I cut into the old liner with a cape chisel at the front



How the liner was split

end near the bottom, as shown in the illustration, and then put the chisel bar into this cut where the metal had been raised and drove it clear through. As the liner was thin, it was an easy matter to rip it through from end to end. It could then be pulled out with the hands.

Before the new liner was driven in, it was well slushed on the outside with lead and oil and we also slushed the cylinder wall. It was checked for length with the old liner, as new liners are sometimes as much as ¼ to ½ in. too long. It is much easier to cut off the surplus length, if any, before the liner is placed in the cylinder. A new liner will probably close up a little when driven home, and a new plunger therefore may need turning down a trifle to fit properly. H. L. WHEELER.

Syracuse, N. Y.

How To Check the Boiler Room

Seeing that a deal of interest is being shown in boiler-room performance and data, I submit a short description of the system used in this plant.

We operate two boiler houses. In one we have three 8,000-sq.ft. B. & W. type three-drum boilers with an allowable working pressure of 385 lb. They are set above three eight-retort underfeed stokers operated with preheated air. The feed-water heater is a deaërating type, and the place of an economizer is taken by three air preheaters.

At the other plant we have three 5,000-sq.ft. vertical water-tube boilers stokered by two five-retort stokers, the setting being designed for use of hog fuel as well as coal.

To check the water consumption and steam flow, we use recording and integrating meters. The water is metered after it leaves the feed pump, the amount and temperature being recorded. A steam-flow meter on each boiler gives a record of the steam output, and the pressure is also indicated on the flow chart. The steam is metered as it leaves the boiler room for the various departments. When this amount is subtracted from the boiler-meter readings, it gives the amount used by boiler-room auxiliaries, and we use the feed-water readings to give us a check on the steam flow. A recording thermometer is installed on the blowdown lines to check excessive blowdown, and this gives us an idea of the amount lost in this way.

The next item is the measurements and quality check on the fuel, which we accomplish in the following manner: The coal is unloaded and elevated to an overhead bunker, representative samples being taken from each car. The coal eventually finds its way into a traveling weigh larry, where it is weighed and dumped into the stoker hoppers, the weight delivered into each hopper being carefully recorded. Samples are again taken at this point. Both samples are analyzed, the car samples being used as a check on the coal delivered at the plant, and the hopper samples are used to work out the day's efficiency. The question of hog fuel is taken care of by analyzing representative samples frequently and reducing the results to a coal equivalent.

A continuous record of the air-heater performance is obtained by placing thermometers so as to get both inlet

BOILER HOUSES—Daily Steam Report.

Day ..... Date .....

	B. & W. @ 175 LBS. GA. BOILER NUMBER				WICKES @ 150 LBS. GA. BOILER NUMBER			
	1	2	3	4	1	2	3	
Hours in Service	24	24	24		24	24	24	
Draft: Windbox	.9	.9	9		2	3	2	
Over Fire	.18	.20	.18		.3	.3	.2	
Uptake	.6	.6	6		.6	.6	.6	
Flue Gas: CO_2	11.3	11.5	11.1		8.7	8.7	8.3	
CO								
Steam Produced	914000	918000	888000		378000	377000	385000	Hog Fuel
Average Rating, Per cent	158	159	154		105	104	84	31000#
Coal Fired, Lbs.	78.940	78.460	78.350		37,030	36,174	27,240	
Bark Fired, Lbs.								70,000
Coal Equivalent of Bark					6.5	6.5	6.5	
Evaporation per Lb. of Coal (Actual	9.2	9.3	9		8	8.1	8.1	
Evaporation per Lb. of Coal (F&A 212)	9.75	9.85	9.54		8.72	8.82	8.82	
Factor of Evaporation	1.06	1.06	1.06		1.09	1.09	1.09	
Overall Efficiency	82%	83%	80%		73%	74%	74%	
Temperatures								
1 Feedwater entering Boiler	205	205	205		170	170	170	
2 Air entering Air Preheater	50	100	50					
3 Air leaving Air Preheater	425	440	430					
4 Gases leaving Air Preheater	250	270	260					
5 Flue Gas leaving Boiler	630	615	640					
Water reading	272700 #							

Fuel Analysis (as fired)

	COAL	BARK
Btu. Per Lb.	11,500	2000
Moisture %	6.1	68%
Ash %	15.00	

Remarks Peak 300%

Engineer .....

Log sheet used in the plant

and outlet temperatures of flue gas and air, which are recorded on a 24-hour chart.

Furnace conditions are controlled by the boiler meters and CO_2 tests. To be sure that the deaërating heater is doing business, we run frequent tests for oxygen, the Winkler method being used. The results from the various meters are calculated every day, and a log sheet similar to the illustration is made out.

Kenora, Ont., Canada. R. G. EDWARDS.

Auxiliary Equipment Too Often Neglected

Engineers are prone to underestimate the importance of learning how to make plant auxiliaries function to best advantage, doubtless owing to their small size compared to the main units.

While in the merchant marine, I shipped as second engineer aboard a tramp freighter that was fully 30 years old. The lighting set was used at night only, and was of a type seldom seen now, being without a governor. As it was not started up till dark, the load, consisting of lights, was steady, some hand regulation being applied if the voltage varied. Later, the owners installed a new outfit equipped with a shaft-governed engine. The ship's engineers, all with twenty or more years' sea experience with large marine engines without governors, actually were not familiar with the new set and persisted in running it with the throttle just cracked open as with the old set. This resulted in a heavy governor knock and the chief threatened to remove the governor. As the voltage could be maintained with small valve opening, they could not see why the throttle should be opened wide, even though I did it once to show that the knock disappeared as soon as the speed was high enough to cause the governor to move away from the stop. Not till the chief visited a naval vessel in the next port would he believe that the throttle should be open wide.

Refrigerating machinery is another piece of equipment that is foreign to many engineers who think they are well informed. I was on another vessel that had a 10-ton ice machine and was told that the task of keeping the icebox temperature down was the worst feature of the job. The chief steward complained constantly of spoiled food, although the machine was amply large for the duty that it had to perform. The cylinder and valve on the steam end were badly worn, and it had a badly sprung crankshaft which caused the bearings to run hot, and for these two reasons the speed of the machine was kept as low as possible. The chief steward proceeded to clean up the icebox when the vessel was in the home port before laying in his supply of food for the coming trip to the tropics. As the outdoor temperature was around 90 deg., the box went to 90 in a few hours and the chief was requested to start the ice machine as soon as he could raise steam on one boiler. I was detailed for this duty.

After getting the machine turning over, I opened up the expansion valve to the coils and carried the suction pressure at 48 lb. and raised the speed of the machine, by means of the adjustment on the throttle governor, to the maximum point, which was about 50 per cent above the usual operating speed. Ordinarily, we carried 15 lb. suction pressure and ran at 100 r.p.m., but it was necessary to bring the box down to the freezing point in a few hours. Of course 48 lb. suction pressure would not be possible after the box was down to the regular temperature, as the ammonia temperature would be higher than the required icebox temperature. But with the box at 90 deg. the highest possible pressure in the coils was none too high at the start, 48 lb. giving a coil temperature of about 32 deg.

I considered the machine doing its maximum duty under these conditions, but when the chief saw the suction pressure, he promptly closed the expansion valve, also slowed the machine to the usual speed. He inquired sarcastically if I ever had operated an ammonia compressor before and if I knew how much coal it took to run the machine at the extra speed. As tactfully as possible I stated that the usual speed and suction pressure would be maintained after getting the icebox down to 22 deg., but that I considered it to be good engineering to follow my plan till it started to come down. He then wanted to know who ever heard of a refrigerating plant carrying 48 lb. suction pressure in the coils; all the plants he had ever seen carried 15 to 20 lb. It was useless to tell him that the coils could evaporate more than twice as much ammonia now as they could at the time the box was down to 22 and the increased speed and higher suction pressure were necessary to enable the machine to handle all the gas the coils could evaporate. I asked permission to operate under these conditions till the box came down to 50 deg., when I would reduce the suction pressure to 40 lb. and reduce it gradually as the box cooled. He refused on the ground that the machine would get a slug of liquid if the expansion valve was left as I had set it. I pointed out that the suction line was not even frosted back to the cylinder and that it would do no harm to carry 60 or 70 lb. in the coils for the first two hours, but got emphatic orders to run at the regular speed and that the adoption of my idea would waste coal and ammonia, and furthermore, he would be responsible for results as long as his orders were carried out.

By the following morning the box temperature was still 52 deg. and the steward was ready to put in his food supply. As we were sailing at six that night, the box was loaded and the chief asked to cool the box as fast as possible. He insisted that the machine was doing all it possibly could and that speeding up would only increase the coal bill. We were in Tampa and had orders to proceed to Norfolk for coal, and though the meat was frozen when it came aboard, most of it was spoiled before reaching Norfolk. The chief was called to account by the port engineer, who had charge of all repairs to ships of that line in the port of Norfolk. After looking over the machine and finding the ammonia end in good shape, although the engine pounded badly and the steam end was badly worn, he placed the blame on the chief, who was demoted to the position of first assistant of one of the company's tugs.

A new food supply for a three months' trip was put in and, after first getting the icebox down to 22 deg., and at my suggestion written instructions were posted that if the box went up 5 deg. or more, the machine was to be operated at the maximum speed till it came down again to the desired temperature, and the expansion valve was to be opened wide enough at all times to frost the suction line clear back to the stop valve on the suction pipe about a foot from the cylinder. Also a short table showing the corresponding temperatures for suction pressures from 10 to 40 lb. was posted for the guidance of the engineers, with the reminder that the coil temperature should be 20 deg. below the icebox temperature with the area of coil surface that we had. This indicated that 17 lb. was the proper suction pressure for our conditions, although a constant icebox temperature was to be preferred to constant suction pressure and no objection would be raised to a variation in pressure of 2 lb. either way as long as the suction pipe did not show superheated gas leaving the coil. With the machine running at full speed and the cylinder getting saturated gas, nothing more could possible be done to increase the capacity of the machine.

Thompsonville, Conn. G. H. HART.

Comments from Readers

Rule of Thumb Is Passing

The editorial in the Feb. 1 issue, "Rule of Thumb Is Passing," prompts me to write this letter. Other editorials and letters have appeared dealing with this subject, but in each case reference is made to the college man and what the colleges are doing or should be doing. I do not wish to infer that this is wrong, but I should like to ask a question which I hope some of the readers of *Power* can answer for me.

If it is good for the many colleges to put forth such efforts to keep their graduates up to a standard, what about the man with only a grade-school or high-school education? Most of the men in power plants today fall into these two classes, and I can say that many of them have fond hopes of getting somewhere in the game. Then when they have got along in years and with probably a family to support, they wake up and find they are not going to arrive at their goal unless they are college men. Does it mean that all these men are fixtures for life in the jobs they fill? Now, if a man gets along in years before he wakes up, I can see why he usually becomes a fixture. But what of a younger man about the age of twenty-five to thirty? Do these men have to stay in minor positions or is there any salvation for them? Can they ever arrive at their goal, which in most cases is above a shift engineer's position without a college degree and, if so, how?

Elmwood Park, Ill. JOHN E. GAARE.

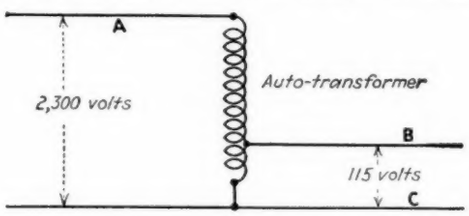
Hazards in the Use of Auto-Transformers

In the article, "Hazards in the Use of Auto-Transformers," by Anthony J. Christopher, in the Feb. 1 issue, attention is called to the hazard when using auto-transformers, because the 115-volt circuit is in electrical contact with the high voltage as indicated in the figure.

Mr. Christopher seems to have lost sight of the use of a ground on the common wire *C*. If this wire is thoroughly grounded, it is difficult to see how a dangerous situation can be created even if the primary and secondary circuits are in electrical contact. Of course it is not always feasible to ground one wire in the primary, but where this can be done, I cannot understand why it is not just as safe as the use of a two-coil transformer.

EARL E. NORMAN, Supt.,
Kalamazoo, Mich. Dept. of Public Utilities.

[If it were possible to make absolutely certain that the common wire *C* would always remain effectively grounded after once being so connected, what Mr. Norman says regarding the hazard on the low-voltage side of the auto-transformer has some merit. However, experience with ground connections shows that under average conditions the effectiveness of these connections is doubtful. The trouble with most grounds is that they are something that the equipment, in most cases, will operate as well without as with the connection effectively made. For this reason these connections are frequently neglected, and when something happens that the ground connection is intended to protect against, the assumed protection does not exist. Unless careful attention is given to ground connections, they are likely to dry out and become practically worthless or the connections corrode off. Even where water pipes are used for grounds, there is always the danger of the connection's becoming corroded or broken off without its being known. There is also the possibility with line *C* grounded, of a ground on line *A* causing the ground connection to burn off and leave the *C* line insulated from ground and line *A* connected to ground. The person called in to repair the trouble, not knowing the condition that exists, is in great danger of being seriously shocked, if not killed. On any system such as shown in the figure, so many conditions can develop to create a hazard to life, that there is only one safe way and that is to insulate the high- and the low-voltage winding and if possible ground the neutral point of the low-voltage winding as an additional precaution. —Editor.]



Auto-transformer connected to obtain 115 volts from a 2,300-volt supply

The Assistant Engineer—What Can He Do?

The circumstances outlined in the letter by F. P. Terry in the Feb. 1 issue, entitled, "The Assistant Engineer—What Can He Do?" are surely well worth the attention of many of our employers of labor.

This assistant engineer ought to consider himself fortunate in being employed by a firm that has so much consideration for old employees, and if this same spirit was more general between employer and employee, discontent, disputes and strikes would largely disappear.

Many assistant engineers are imbued with the idea that they could fill the chief's job better than the "old man," and wonder why the firm keeps one who has slowed up physically, although quite alert mentally, and who is considered old-fashioned by the younger engineers. Going to the directors without consulting the chief first (which he evidently does) when he has improvements to suggest, is surely not the correct procedure. Just let this assistant engineer put himself in the chief's place for one day, and imagine how he would feel if he found any of his assistants going to the directors with suggestions for the betterment of the plant, without first talking the matter over with him.

Mr. Terry's advice to this assistant engineer is sound; he ought to look for another job. Even if old Andy should retire, it is doubtful if the firm would offer the chief's position to this assistant, not because of his lack of engineering ability, but rather for his want of tact and spirit of co-operation, without which no plant can be run smoothly and successfully.

If sentiment is responsible for this particular firm keeping old Andy employed when he is 70 years old, then let us hope that this sentiment may increase until the workingman can look forward to his declining years without the dread of want hanging over him.

Vancouver, B. C., Canada. JOHN MELVILLE.

Precooling Liquid Ammonia

There appears in *Power* of Jan. 25, an article by William Jahnke, entitled "Precooling Liquid Ammonia." This article was read before a gathering of refrigerating engineers in the West, and there doubtlessly was a discussion which, unfortunately, I have not been able to read. As the article is published for the general advancement of public knowledge and as there appear to be a number of grave errors, it is incumbent upon those who discern errors to point them out.

It appears that the article was inspired by a practice that is coming into vogue lately through the efforts of air-compressor builders who have turned to manufacturing two-stage ammonia compressors. This practice of intercooling the gas between the high- and low-pressure stages is accomplished in various ways, the more prominent ones being first by taking a portion of the coldest circulating water and passing it through a tubular cooler wherein the warm gas leaving the low-pressure compressor is made to pass among the tubes, while the water circulates on the inside of the tubes, and thus reduces the temperature of the gas some, before it enters the high-pressure compressor.

This device causes the final heat of compression to be somewhat lower than it would be if the device were not used and thus saves some on the power necessary to drive the compressor.

Neglecting the amount of power for circulating the water, any heat given to the circulating water and carried out of the system is a clear gain, for it is heat that does not have to be handled again.

A second method is one wherein what is commonly known in the refrigerating industry as an accumulator, is used. This device is shown by Mr. Jahnke in his first plan. It consists of a shell containing an internal coil through which all the liquid ammonia used is made to pass. Into the bottom of this shell liquid ammonia is expanded and cools the liquor in the coil and also cools the gas on its way from the low- to the high-pressure cylinder in its passage through this shell.

The third method is to inject a small quantity of liquid ammonia into the suction of the high-pressure cylinder, thus cooling the gas from the low-pressure discharge temperature to its saturation temperature at intermediate pressure.

These cases are cited to show there is nothing new or novel about precooling or intercooling. Engineers have resorted to it with varying success ever since Linde built his first ice machine.

Over twenty-five years ago Sulzer Bros., of Winterthur, Switzerland, expanded 10 per cent of the liquid used in precooling.

It must be borne in mind that except in the case where the heat is given to the cooling water, you are simply taking heat out of one spot in the system and putting it into another. Whether the transfer can be done advantageously is a question of proper manipulation. Mr. Jahnke has given the impression in his article, that he has not given the question of temperature or pressure used in his plans a great deal of consideration.

Why he should have designated 95 deg. F. as the temperature of the liquid ammonia at that pressure of 185 lb. in the condenser, seems to be because a table states that the ammonia gas will have to be reduced to that temperature before it will liquefy at 185 lb.

There is nothing that can be construed to mean that when the liquid has dropped to the bottom of the condenser and has 65 deg. F. water running over the coils, this liquid must remain at the temperature of 95 deg.

Manufacturers so design condensers that the liquid will leave, within a few degrees of the circulating water. Circulating water at 85 deg. F. shows a poor effort at economy. Also it would be a step of far greater value than the attempted precooling, to install more condenser surface and thus reduce head pressure and power consumed.

In his first plan Mr. Jahnke shows an accumulator interposed between the evaporator and the compressor. Liquid ammonia at 95 deg. F. is made to flow through the coil in the accumulator, while suction gas at 5.5 deg. F., the temperature of the vapor at 20 lb. is made to pass between and around these coils on its way to the compressor.

Space will not permit going into the question of a heat transfer from liquid at 95 deg. to a gas at 5.5 deg. F., but the information gained from the legend on the drawing that the liquid is reduced to 35 deg. F. on leaving the precooler will be accepted.

This implies that the gas has taken 60 deg. of superheat from the liquid. It has been stated in the text that in the neighborhood of 43 lb. of liquid ammonia will have to be circulated per minute to produce a duty of 100 tons of refrigeration.

The volume of the vapor from a pound of the liquid evaporated at the temperature and pressure in the evaporator is 8.06 cu.ft. As 43 lb. are evaporated per minute, the volume of vapor arriving at the accumulator per minute is 43×8.06 cu.ft., or 346.58 cu.ft. per min.

The total heat in each pound of this vapor as it leaves the evaporator is 613.5 B.t.u. and in 43 lb. per minute would be 43×615.5, or 26,380.5 B.t.u. The liquid has parted with 60 deg. of its heat, so the suction gas must have taken this heat up, for the plan shows no other way for it to be dissipated.

The specific heat of liquid ammonia at this range of temperature is taken to be 1.1. B.t.u. per lb., so each pound of liquid must lose $60 \times 1.1 = 66$ B.t.u.

If each pound of gas had a total heat content of 613.5 B.t.u. when it arrived at the accumulator, when it arrived at the compressor it would contain $613.5 + 66 = 679.5$ B.t.u., which would cause its temperature to rise from 55, the saturation temperature, to 125 deg.

The absurdity of this plan as shown is apparent. If the gas has a temperature of 125 deg. at the start of compression, what will the temperature be when compression is finished? Something enormous, and impossible to sustain.

The question now arises, What could be done to make the plan workable?

The first thing to be done is to get the liquid ammonia cooled to within a few degrees of the coldest circulating

water available. If a double-pipe condenser is used, the water generally enters at the bottom, so the liquid ammonia leaving will have a temperature near the entering water. If other types of condensers are used where the water after taking up heat passes over parts of the condenser that contain liquid ammonia about to leave the condenser, this liquid must be recooled in some separate device. The liquid now is ready to enter the accumulator and has been divested of as much heat as possible.

In the second plan Mr. Jahnke neglected to consider the result of increasing the volume the high-pressure suction has to handle. In this case he disturbs the most economical ratio the designer has found, sets up a dangerous stress in the crankshaft and increases the final heat of compression as well as the m.e.p., with a reduction in volumetric efficiency and for what?

To gain a possible 2 or 3 per cent in the evaporator. If precoolers were the enormously advantageous affairs Mr. Jahnke would have us believe, every plant would be fitted with them now or the owners would be idiots.

Mr. Jahnke should keep in mind when figuring that the value of certain terms may change if considered at the rate of minutes instead of hours, at which they were evaluated. One hundred B.t.u. per minute is a high rate per square foot per degree, as Mr. Shipley has shown in his article in *Power*, Feb. 1.

Union City, N. J. F. P. MacNeil.

Tuning Up The Heating System

Carl Wildey, in *Power*, Nov. 23, 1927, and W. A. Courchene in the Dec. 8, 1927, issue, contribute some useful information on "Tuning up Heating Systems."

In many instances investigation of complaints about the lack of steam reveals that someone with an artistic eye had painted the radiator a beautiful aluminum bronze. The thing would look all right, but the effect on the heat delivery can be understood. Prof. John R. Allen gives the value of this finish as 0.752 of that of bare pipe. This is lower than the figure quoted by Mr. Courchene, and it can be seen that the heat delivery can be increased by about 33 per cent by giving the radiator a coat of terra cotta enamel, which has a value of 1.038 of that of bare pipe.

I recollect an office from which a demand for more steam was as regular as a north wind in winter. As the radiation would have been sufficient if the windows had been in good condition, my advice was to weatherstrip the windows or to install storm sash. The advice was neglected until there was a change of occupants, when storm sash was installed and the trouble ended.

On another occasion an S.O.S. came in that the occupants of an office were freezing and the radiator cold. On going to see what was the matter, I found the foreman and his clerk hugging the radiator, which was really cold. The tuning up in this case consisted in opening the radiator valve. One of them had forgotten that he had closed the valve, and both of them thought it was open.

In still another building complaints were frequent that a certain office was always either too hot or too cold. On one side of a desk was a man who had evidently been raised within the Arctic Circle, and on the other side was one who seemed to have been born in the Tropics. It was a case requiring tact, so I showed them the radiator valve and explained its working, assuring them that there was absolutely no danger in operating it, and told them to adjust it to suit themselves.

A single-room building, about 95x300 ft., had only about one-third the radiation that was necessary to heat it properly, so it was decided to install unit heaters.

In another part of the plant there was a blast coil and fan which heated several floors of a couple of buildings. During the day the fan operated under favorable enough conditions—that is, the air from the different floors and buildings could return to the fan to be reheated and recirculated—but at night all doors were closed, and any air forced into the rooms had to escape through leaky windows, and air from outdoors had to enter somewhere and be heated.

Assuming a room temperature of 68 deg., an outdoor temperature of 20 deg., a plenum chamber temperature of 160 deg., and a makeup-water temperature of 40 deg., there would be more heat wasted in allowing the air to escape outdoors than would be wasted in allowing the condensation to go to the sewer. The obvious thing to do in this case was to substitute direct radiation for the fan and blast coil and move the latter to the single-room building where the air could be recirculated both day and night.

It used to be, and is yet in many places, considered important that an even temperature be maintained in lumber-drying kilns. It was the belief that the slightest change in temperature would set up contraction and expansion strains and produce internal and external checking, depending on whether the change was upward or downward. The knowledge on the subject was so exact that there was no room for argument, and if the lumber was not right nothing was more certain than the temperature had been allowed to vary.

While on my holidays some time ago, I was looking at some examples of lumber drying. Along with me was a heating man who related an experience that his company once had. They had sold a dry kiln to a firm who wished to know if it would be practicable to shut the steam off the kiln during the night and have it on only during the day. They were assured that it would be practicable, but that it would take longer to dry a batch of lumber. After operating in this way for some time, the purchaser reported, that instead of taking longer the time required was actually less and also that the lumber was in better condition.

On returning to work, I reported what I had learned to our lumber dryer, who decided to try it. He has since told me that quartered stuff that used to take eight days to dry can be in the shop in seven days, and heavy axle stuff that used to take ninety days can be dried in fifty days, and the lumber is in better condition.

While the saving of steam is not in proportion to the reduction in time, it is evident that the capacity of the kiln is nearly doubled. As the dry kilns were overcrowded, that itself was worth while.

Recently, I advised the occupants of a certain office to sacrifice beauty for utility and paint their aluminum-finished vertical-section cast-iron radiator with terra cotta enamel. For awhile they held off, probably not wanting anyone to have a laugh at their expense. However, as the cold weather continued, they decided to try it on the quiet. After the new finish had been applied, I was urgently requested to go and see the result. The heat coming from it, they said, was "something awful."

Toronto, Ont., Canada. R. McLaren.

Fineness and Structure of Pulverized Coal*

Fineness Obtained in the Mill and Its Influence on Ignition—Structure of Pulverized Coal and Its Dependency upon the Kind of Coal and the Method of Milling

By P. ROSIN and E. RAMMLER

PULVERIZATION is not an isolater process, but is a part of the complete combustion system and should be treated as such. The mills should be flexible enough in their adjustments to secure various degrees of fineness to accommodate them to meet the requirements of the different kinds of coal that are likely to be burned under the boilers. It is therefore desirable to consider the influence of the degree of pulverization on ignition and flame propagation.

Pulverized coal is consumed by surface combustion, and the rate at which each coal particle is burned therefore depends upon the surface exposed, or upon its relative degree of fineness.

It is essential that the temperature of each coal particle be raised as quickly as possible to the ignition point in order that it may produce sufficient heat to sustain its own combustion at the proper rate. The time element must decrease in a water cooled-furnace in inverse proportion to the cooling effect of the furnace. Fineness of pulverization and volatile content of the coal are governing factors. As the combustion rate, the fineness of the coal particles ceases to be a factor. The degree of fineness need then be sufficient only to insure freedom of travel during the time allowed for combustion, to prevent any unburned particles from reaching and depositing on the heating surfaces.

Practice has shown that the minimum fineness permissible corresponds to that obtainable through a 76-mesh screen, with an inappreciable residue. The pulverized coal must also contain a certain percentage of very fine particles, the proportion being dependent on the volatile content of the coal and the design of the furnace. Extreme fineness is not to be recommended, as this greatly increases the power requirements of the mills and reduces their capacity. Extreme fineness may also be the cause of furnace trouble.

TABLE I—RESULTS OF MEASURED FINENESS

No.	Kind of Coal	Type of Mill	Make	Per Cent Residue on Screen—200 Mesh	178 Mesh	127 Mesh	76 Mesh
A—1	Westphalian	Tube	Polysius	19.1	14.8	7.2	1.6
2	High-volatile	3 roller	Maxecon	12.4	9.1	4.0	0.4
3	.....	3 roller	Maxecon	19.4	15.9	6.1	0.4
4	.....	3 roller	Rema	7.9	5.6	1.2	0.4
5	.....	Ball*	Fuller	6.3	5.6	1.2	0.4
B—1	Westphalian	Tube	Polysius	19.6	15.6	7.2	0.8
2	Low-volatile	3 roller	Maxecon	20.4	17.8	7.2	0.8
3	.....	3 roller	Rema	6.0	3.8	0.4	0.0
4	.....	Ball*	Fuller	5.6	4.0	0.8	0.0
C—1	Saxony	Tube	Polysius	27.2	23.4	11.2	1.6
2	Anthracite	3 roller	Maxecon	23.6	20.4	10.0	1.2
3	.....	3 roller	Rema	6.1	4.5	0.8	0.4
4	.....	Ball*	Fuller	5.0	4.0	1.2	0.0
D—1	Briquets	Tube	Polysius	30.2	26.6	15.2	3.2
2	.....	3 roller	Maxecon	18.3	15.5	6.0	0.4
3	.....	3 roller	Rema	10.3	7.8	2.0	0.4
4	.....	Ball*	Fuller	4.6	3.2	0.8	0.0
E—1	Rhenish	Tube	Polysius	19.6	16.7	9.3	3.2
2	Brown Coal	3 roller	Maxecon	16.8	14.0	6.0	0.8
3	.....	3 roller	Rema	10.3	7.9	2.4	0.8
4	.....	Ball*	Fuller	9.7	8.0	2.8	0.8

*Vertical.

TABLE II—DISTRIBUTION OF FINES FROM 0 TO 20 μ (20 MICRONS)

No. of Coal as Listed in Table I.	Kinf of Coal	Residue By Sizes—20 μ Per Cent	40 μ Per Cent	60 μ 250 Screen Per Cent	75 μ 200 Screen Per Cent	88 μ 175 Screen Per Cent	120 μ 125 Screen Per Cent	225 μ 75 Screen Per Cent
A-1	Wesphalian High-Volatile	63.0	35.9	22.8	19.1	14.8	7.2	1.6
E-1	Rhenish brown coal...	74.8	45.5	24.8	19.6	16.7	9.3	3.2

very fine coal particles ignite more quickly and burn more rapidly than the larger sizes, *it therefore follows that the fineness of the pulverization should be increased with low volatile coals and with increased cooling of the furnace walls.*

This conclusion refers only to the ignition of the coal. When the heat generated becomes equal to or exceeds that absorbed by the boiler and furnace walls, so that a practically constant temperature prevails to maintain the

Until recently, it was not known how the fineness and shaping of the pulverized product was influenced by the natural differences of the coal. It is conceivable that the more brittle and easily ground coals will contain a greater percentage of extreme fines and that this, in turn, largely depends upon the original structure of the coal.

As the time required for the combustion of each particle is governed by the ratio between its surface area and its weight, it is clear that a particle will be better suited for combustion, the farther that its shape deviates from that of a perfect cube or a sphere. In other words, irregularity in shape is desirable.

An investigation of the physical character of pulverized coal, in regard to the size, shape and distribution of the individual particles is therefore of both technical and commercial importance in pulverized-coal firing. For this reason the German government requested the pulverized-coal committee to conduct a series of scientific tests in order to determine whether or not the shape and fineness of the coal particles depend upon the kind of coal or the operating characteristics of the mill in which it is pulverized.

These tests were conducted with four well-known mills, which included all the important types with the exception of the hammer mills. It is regretable that the Raymond mill could not be included in this list, because no suitable installation of this type was available at that time.

Each of the mills was tested with five kinds of coal: Westphalian high-volatile, Westphalian low-volatile, Saxony anthracite, central German briquets and Rhenish brown coal.

Fineness

Table I shows the degree of fineness obtained by each mill, according to the measurements taken at the government laboratories.

Particular attention is called to the fact that, for example, the results obtained with the 178-mesh screen should not be interpreted as a basis of the relative merits of the mills. These results were obtained by the intentional arrangement of the tests. The Rema and the Fuller mills were adjusted for fine pulverization, whereas the Maxecon and Polysius mills were adjusted for a coarser pulverization. The degree of fineness does not depend on the grinding method employed, but on the flexibility and range in adjustment that are provided. The claim that mills of the air separating type yield a coarser product is unfounded.

*Abstract from article in January, 1927, issue of *Zeitschrift des Vereines Deutscher Engenieure.*

The frequent claim that one type of mill delivers a more uniform product, does not hold. Every pulverized coal is uniform in its composition, or in other words, shows a steady trend in the size of its particles. There is no difference in grade. It is impossible with any screening or separating method to obtain a pulverized product containing only particles which vary in size between narrow limits. The difference is found only in the distribution of the different size particles. If the kind of coal, grinding method and screening influence the composition of the pulverized coal, this will be made apparent only by the slope of the curves for any given per cent of residue and a given screen.

When curves (residue plotted against mesh) representing different kinds of coal ground by the same mill are compared, it will be found that the Rhenish brown-coal curve is decidedly flatter than the rest. This may be explained by the large amount of lignite contained in this coal. Lignite is difficult to grind and has a tendency to splinter into minute flat rods, which naturally results in a greater residue in the 76-mesh screen, even though the residue may be the same as that from the other coals with the finer-mesh screens. This phenomenon is more apparent in the Polysius tube mill than in the others. The lignite may be ground finer in the screen-type mills than in the air-separating types, in which the fine particles of lignite have a better opportunity to escape from the grinding elements.

Amount of Extreme Fines

It is obviously impossible to classify the composition of the impalpable powder which will pass through the 200-mesh screen. In order to learn whether the distribution of the extreme fines below 75 microns (0.074 mm.) uninfluenced by the kind of coal and method of milling micro-photographs showing a 100: 1 magnification were made. These did not show any evidence that the distribution of the different size particles below 75 microns mesh, are appreciably influenced by the kind of coal. On the other hand, the kind of coal has a distinct influence on the shape of the particles. The tube mill product appears, in part, to contain a greater amount of the extreme fines under 75 microns than the other mills, all of which show greatly similar curves for particles between 75 and 225 microns. This may be explained by the fact that the fines in the tube mill are not as quickly removed and are therefore subjected to additional grinding.

It must also be remembered that these micro-photographs show only a very small amount of coal which may or may not represent a fair average sample. The only way by which a true picture of the distribution of the extreme fines is obtainable is to apply an air separation or sedimentation process.

Such an investigation was made by the Berlin-Dahlem laboratory. Samples of the coal listed as A-1 and E-1 in Table I were passed through approximately 250-mesh screen and the extreme fines were divided into three classifications by air separation, namely, 40 to 60 microns, 20 to 40 microns and 0 to 20 microns. The results are shown in Table II.

Two general conclusions may be drawn, namely:

I. The composition of pulverized coal is practically independent of the kind of coal, method of grinding and separations.

II. For the extreme fines between 0 and 75 microns this condition is not proved, but it is probably true by theoretical deduction and their apparent agreement with the results of tests.

Structure Versus Method of Grinding

Micro-photographs were made to determine the influence of the kind of coal and grinding method. A great variation in the structure of the coal particles was apparent. Rectangular and approximate quadratic and trapezium forms occur most frequently. Triangular and oval shapes occur less frequently.

The claim that high-speed mills produce leaf-like particles was not confirmed by the photographs. Likewise the claim that the air separating types of mills produced particles differing in shape and surface structure from those obtained with high-power screen-type mills did not prove to be true. At times the tube mill would produce jagged, sharp-cornered particles, but their occurrence was too infrequent to draw such general conclusions. *It may therefore be asserted that no relationship exists between the method of grinding and a specific shape or surface character of the particles produced. On the other hand, the physical structure of the coal exerts a powerful influence on the shape of the particles and their surface character.*

Conclusion

Since the fineness and shape of the pulverized-coal particles is not influenced by the method of milling, the selection of a mill should be based on the commercial efficiency obtainable per ton of coal pulverized.

How To Prevent Carryover*

Simple and Reliable Tests for the Control of Boiler Blowdown

FOAMING and, to a large extent, priming, or what is generally known as "carryover" with the steam from boilers, is dependent almost entirely on the concentration of total solids in the boiler water. Of course mechanical construction, rating operation, oil and organic impurities, etc., have their influence on the amount of carryover with the steam and must be taken into consideration. However, at plants where these factors are normal, the concentration of the boiler water can be controlled so that carryover is reduced to a minimum.

With carryover depending on the concentration of total solids in the boiler water, it would appear that a definite concentration of total solids in grains per gallon could be determined for boiler water and if the concentration were held below this, there would be no foaming. This is not the case, because the amount of total solids that can be carried in boiler water depends not only on quantity, but also on kind. The boiler water contains solids both in solution and in suspension.

Effect of Suspended Matter

It is a well-known fact that boiler water in which there is little suspended matter, can carry a very high concentration without foaming but, if any suspended matter such as mud, etc., gets into the boiler, foaming immediately results. On some artesian-well water the hardness is very low and the sodium-salt content very high. Boilers using this water frequently run at a concentration of over 2,000 grains per gallon. In other localities the sodium-salt content may be low and the hardness so high that a concentration of only 100 grains per gallon can be carried.

The reason for this is that, with the artesian well water of low hardness, practically no mud is formed in the boilers and consequently a high concentration can be carried. The "hard" water forms mud and lowers the concentration that can be carried.

Chart Shows Permissible Concentration

The accompanying chart shows the relationship in grains per gallon of the amount of total solids to the amount of suspended solids that can be carried in boiler water. The curve is based on actual operation of a large number of widely scattered plants and covering a period of several years. A margin of safety has been allowed on this curve which is based on 175 per cent rating. It will, of course, vary slightly with higher or lower ratings. Observation of this curve shows that the concentration of total solids that can be carried, drops rapidly on the increase of the amount of suspended matter.

The most accurate method for determining the concentration of both soluble and suspended solids in the boiler water is by evaporating samples of filtered and unfiltered water. The weight of the solids from the filtered sample gives the amount of soluble salts and the difference between the weight of the filtered and unfiltered samples gives the suspended matter.

The concentration of boiler waters should be run every day, but to evaporate samples of water from each of a large number of boilers often requires considerable time of a laboratory chemist. A system has been devised that requires the evaporation of only two samples of boiler water a day. This is done by evaporating samples from the

*Abstract of article in January, 1927, issue of "Clean as a Whistle," published by the Chicago Chemical Company.

boiler showing the highest chloride concentration only.

Samples of water are taken daily from the water columns of each boiler, the water column being thoroughly blown down before taking the sample. A tee and valve should be provided in the blowoff line of the water column to facilitate taking these samples. Allow the samples to cool and filter.

How to Make Tests

Run a chloride determination on each sample in the following manner: Place 58.3 c.c. of filtered boiler water in a white porcelain dish and add two drops of phenolphthalein indicator, which will give a pink color. Add sulphuric-acid solution until the pink color disappears. Then add three drops of potassium-chromate indicator. Through a burette add N/50 silver nitrate solution until the yellow color of the potassium chromate just changes to a reddish brown tinge.

Record the number of cubic centimeters silver nitrate used as chlorides or "Cl," which number is grains per gallon direct. Save at least 200 c.c. of the unfiltered boiler water showing the highest chloride reading and send to the laboratory.

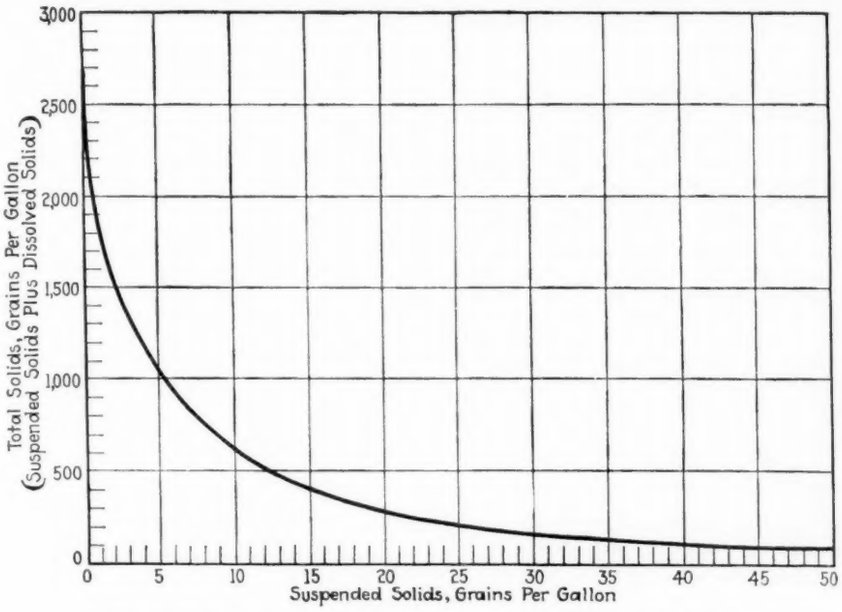
The sample should be thoroughly stirred or shaken before filtering for the chloride test and before adding to the bottle sent to the laboratory, otherwise some of the suspended matter will settle out and the ratio of suspended matter to total solids will be changed. Mark on the bottle to be sent to the laboratory, the chloride reading obtained.

The laboratory will then evaporate 58.3 c.c. samples of both filtered and unfiltered boiler water. The weight of the solids in milligrams gives grains per gallon direct. The unfiltered sample gives the total solids and the filtered the dissolved solids. The difference between the two are the grains per gallon of suspended matter.

The total solids divided by the chloride reading gives the grains per gallon of solids per cubic centimeter of silver nitrate solution or per grain of chloride, and is called the "total solids constant."

If the chloride contents of the other boilers are multiplied by the total solids constant, the grains per gallon of total solids for each boiler is then determined. The usual procedure is to use the total solids constant determined on the previous day and multiply by the chloride readings to obtain the total solids for each boiler. The total solids of each boiler is posted on a small blackboard in the boiler room and the boilers are blown accordingly.

A comparison of the ratio of suspended solids to total solids in the sample sent to the laboratory, with the ratio from the curve, will tell if the boiler water contains too high a concentration of total solids. Those boilers that are above the allowable total solids content are blown down more, and those far below are blown less. The allowable concentration should be placed on the board and boilers then blown accordingly.



Curve indicating total solids that may be safely carried for various amounts of dissolved solids

Example Worked Out

Following is an example of this method of controlling concentration. Chloride content of boiler No. 1 is 20; of No. 2, 40. The laboratory reports on boiler No. 2 sample: Total solids, 300; suspended solids, 25. The total solids constant is 300 ÷ 40 = 7.5. The total solids of No. 1 is then calculated as 7.5 times 20 (chloride reading) or 150.

Referring to the curve, 25 suspended solids allows total solids not to exceed 200, while that of No. 2 is 300. No. 2 boiler must therefore be blown down more.

Blowing down will decrease the suspended solids, so that the boilers should be able to carry approximately 225 grains total solids.

As long as the ratio of suspended to total solids does not materially change, the 225 can be carried as standard. If for any reason the ratio of suspended to total solids rises, it will, of course, be necessary to reduce the allowable concentration. This method has proved to be surprisingly accurate and gives good results without unnecessary work of evaporating a large number of water samples.

Governor-Oil Pumping Systems for Hydro-Electric Units

A recent report by the Hydraulic Power Committee of the National Electric Light Association states that the central oil-pressure system with separate motor-driven pumps and spare waterwheel-driven pumps has, where used, been reported to be entirely satisfactory and results in a minimum number of pumps to be operated. Satisfaction was reported with pumps having combination motor and waterwheel drive, with sufficient spare units. Some of the companies have had entire satisfaction with motor-driven pumps only.

Some of the companies prefer individual governor oil pumping systems for each unit, while others also prefer that these individual units should be interconnected with each other and with a spare unit for use in case of breakdown.

The gear-type pump is almost universally used for governor oil pumping. Some companies are using screw-type pumps with satisfactory results. Cases were reported where screw pumps have operated continuously for many years. The screw-type pump runs more quietly than the gear type, but the efficiency is reported to be somewhat lower. In one company, the screw-type pump has been made standard for future developments and replacements.

Where water is used as a governor fluid, the centrifugal type of pump has been used.

Preference was also expressed by some for pressure oil tanks operated on the volume control basis instead of pressure control, as they tend to maintain a sufficient volume of oil at all times. With reference to the closed versus the open governor-oil system, some companies have found that the alternate pressure and vacuum to which oil is subject in the closed system causes a breaking down of the oil, necessitating its complete replacement after a period of six months or more. No such condition occurs with the open system, with which the same oil has been used for long periods, with the addition of small quantities of oil for makeup at infrequent intervals.

Many companies use the same brand of oil both for governor and lubricating purposes, thereby effecting some economy and eliminating the necessity of carrying in stock a special oil for the governing equipment.

Hints on Operating Direct-Current Equipment in Parallel

AT ITS regular monthly meeting of the Philadelphia section of the Association of Iron and Steel Electrical Engineers, held in the Philadelphia Engineers' Club on March 5, there was presented a symposium on "Parallel Operation of Direct-Current Apparatus." This symposium was sponsored by D. M. Petty, and comprised three papers: "Parallel Operation of Direct-Current Generators and Direct-Current Generators with Synchronous Converters," by Ernest Pragst; "Parallel Operation of Rotary Converters," by William B. Shirk; and "Parallel Operation of Mercury-Arc Rectifiers," by O. K. Marti. The following is a summary of the papers and discussion:

In the parallel operation of direct-current machines the two primary questions are division of load among the various units in service and the stability with which this division is maintained. Division of load is obtained by a change in voltage, which may be accomplished by a change in speed or by adjusting the field rheostats. The latter is the usual method. Machines having poor voltage regulation possess stable characteristics for load division between two or more units. This is an inherent characteristic of the shunt-wound generator, on account of its dropping voltage characteristics.

Shunt-Wound Machines

When two or more shunt-wound machines are adjusted for the proper division of load, if one machine tends to take more than its share, the voltage of this machine will decrease and that of the other machines will tend to rise. The effect of the rising voltage on the machines tends to cause them to take more load, where the decrease in voltage on the one machine will cause this machine to reject load. From this it is evident that the action is such as to maintain the division of load as long as the conditions accompanying a division of load is maintained. If for any reason the speed of one machine were to change, this would result in a change in voltage that would be reflected in a change in the division of load. It is therefore essential that the governors of the prime movers be in condition to give a fixed speed for any particular setting.

Division of Load

A proportional division of the load may be made between two or more units at any particular point on the load curve, but this proportion will not be maintained unless the voltage regulation of all machines is the same. This is generally not a serious matter, as the machines may be adjusted for the proper division at near full load, and at less than full load the division will, in most cases, be satisfactory for all practical purposes.

If two machines of dissimilar voltage regulation are connected in parallel and their voltages adjusted so that at full load the proper division is obtained, at less than full load the machine with the poorer voltage regulation will take more than its proportional share of the load and above full load will take less than its proportional share.

Compound-Wound Machines

Successful parallel operation of compound-wound generators depends upon the same fundamental principles that apply to shunt-wound machines. On account of the better voltage regulation of compound machines load division among the different units in a group of machines connected in parallel may not be as stable as with shunt machines. This is particularly true where the machines are over-compounded, as sometimes happens in railway work. Successful parallel operation of two or more compound machines requires that the junction between the series field and armatures of all machines be connected with an equalizer.

Where trouble is experienced with machines operating in parallel, characteristic curves should be taken from the various machines and, if these are different, the machines should be adjusted to make the curves as nearly alike as possible. A change in the characteristic curves is largely a matter of experimentation, by changing the compounding shunts, the resistance of the series-field circuits, removing or adding shims under the polepieces, adjusting the brushes, etc.

Although direct-current generators and rotary converters have been operated in parallel where conditions are ideal, as a general proposition it is advised against. The difficulty in operating these two types of equipment in parallel is due largely to the fact that one is a generating and the other a conversion device. On the rotary converter the alternating-current and the direct-current ends are connected with a metallic circuit, and the voltage on the direct-current commutator bears a fixed ratio to the voltage on the alternating-current circuit. Therefore any disturbance on the alternating-current side is reflected to the direct-current end of the machine and may affect the voltage in a way to prevent satisfactory parallel operation. Where a motor-generator set is used to convert alternating current into direct current and is operated in parallel with direct-current generators driven by other types of prime movers, the difficulties that occur when operating a rotary converter in the same way are not experienced.

Where rotary converters are operated in parallel, no serious difficulty should be had if they are supplied from the same source of alternating current and they and their auxiliary equipment are properly designed and adjusted to give the correct characteristics for parallel operation.

Where rotary converters are being supplied from separate sources of alternating current, trouble will probably be experienced in operating them in parallel on the direct-current side. The two sets of machines will be affected differently on the two systems. For example, the voltage on one alternating-current system may rise when that on the other system falls. These effects would be reflected through the machine and cause an unbalancing of the voltage on the direct-current sides and a shifting of the load to the machine having the highest voltage.

A frequency disturbance may cause hunting of rotary converters and surging of load between them or other machines they may be operating in parallel with. This hunting will cause surges of current between the machines, producing serious sparking at the brushes, and may cause a machine to fall out of step and trip off the system, under unfavorable operating conditions.

Mercury-Arc Rectifiers

Many of the difficulties encountered in operating direct-current generators or rotary converters in parallel do not exist with mercury arc rectifiers, which have been used on a large scale in Europe and to a limited extent in this country. The current can flow only one way through the rectifier, from the alternating- to the direct-current side, therefore there can be no feeding back from the direct- to the alternating-current system. As long as the vacuum is maintained constant, the voltage drop across the rectifier itself is constant. Any change in voltage is due to the transformers and connections outside the rectifier, consequently any voltage changes in the rectifier to obtain the proper division of load must be taken care of in the transformers. The proper division of load among two or more rectifiers in parallel depends upon the same principles that have to be observed in operating other types of direct-current equipment in parallel.

Rectifiers connected to different sources of alternating-current may be operated in parallel, even if supplied from a 25- and a 60-cycle system. This class of equipment is now in operation under these conditions. In operating direct-current generators on rotary converters in parallel with mercury-arc rectifiers, there should be no difficulty after the necessary adjustments are made to obtain the proper division of load.

News in the Field of Power

Delray No. 3 in Construction —More Edison Projects

Work has been started on the foundations of Delray power house No. 3, of the Detroit Edison Co., which will be equipped, at the start, with two 50,000-kw. turbines. The new power house is to be situated on the filled ground between the present power plant and the harbor line of the Detroit River.

Both stoker firing and pulverized coal are under consideration, the final decision not having been made as yet. About $1,500,000 is to be expended on this project during 1927; the plant is to go into service some time in 1928 and will cost perhaps $9,500,000 for the first section of 100,000 kw.

Installation of the sixth and last 50,000-kw. turbine at Trenton Channel is being rushed in continuation of the work that has been under way during the last two years on units Nos. 4 and 5. This project will call for $5,000,000 to complete the construction of these turbines and to install turbine No. 6. Only half of this amount is to be expended this year, however. With the installation of No. 6 the capacity of this power house will be 300,000 kw.

The fifth turbine, a 30,000-kw. machine, and one boiler are to be installed at the Marysville power house at a cost of $1,900,000. This includes the outlay of economizers for boilers Nos. 1 to 4. The final capacity of the Marysville power plant will be 110,000 kw.

League Fights Power "Grabs" in Adirondacks

E. W. Cady, secretary of the Adirondack Civic League, issued a comprehensive statement March 9 on the bill amending sections of the conservation law, relative to the regulation of streams by storage reservoirs, introduced in the Legislature Feb. 28 by Assemblyman Willis H. Sargent, of Syracuse, at the request of the league and the Society for the Protection of the Adirondacks.

The Sargent bill, Mr. Cady said, has as its object the protection of the Adirondack Park from exploitation by power companies through river regulating districts organized under the guise of "public welfare, including public health and safety," and provides that real public necessity must be shown in order to establish a river regulating district, and that an adequate compensation be paid the state for its land and services used.

State Owns Reservoir Sites

The state owns in the Adirondack Forest Preserve about 30,000 acres of land essential to the creation of storage reservoirs, and through this ownership controls the regulation of the streams heading in the Adirondacks. It is estimated that the increased value of water-power rights created by the storage reservoirs already built and under consideration is in excess of $100,000,000.

The existing conservation law under Section 7a provides for the creation of river regulating districts by which storage reservoirs may be built and state land may be taken only for the purpose of public welfare, including public health and safety. The act enables the state credit to be used, gives the right to condemn property and provides means of assessing the cost upon all property owners benefited, regardless of their willingness to participate.

The attempted amendment of the constitution in 1923, defeated by a majority of nearly 500,000, was to enable the power companies to take state land in the Adirondack Forest Preserve for power purposes. The opposition to the existing law on the part of the civic associations is based upon attempts to utilize it for power purposes and inadequate compensation to the state for its land and services.

Metropolitan A.S.M.E. Hears Centrifugal Pump Studies

At a meeting of the Metropolitan Section, A.S.M.E., March 9, 1927, two papers were read on centrifugal pump design and performance.

A paper by Prof. W. B. Gregory, of Tulane University, discussed the pumping of clay slurry—a mixture of water with 25 to 30 per cent of clay in suspension—with determinations of the loss of head in straight pipe and in elbows, and the characteristics of the pump when handling such material. The studies were undertaken in connection with a project to make portland cement from the precipitate in settling basins of the water filtration system of the City of New Orleans.

Analysis of Performance Curves

The critical range of velocity was identified, and above this velocity the loss of head appeared to be proportional to the 1.90 power of the velocity, not unlike the results for pure water. Below the critical velocity, curiously, it seemed that the loss of head is independent of velocity, contrary to the behavior of pure water. There is no explanation of this phenomenon evident at the moment. In the discussion it was brought out that there is wide variation in slurry as handled by cement mills, the material often running to a much higher solid content than that used in these studies.

A second paper, "A Method of Analyzing the Performance Curves of Centrifugal Pumps," by Jos Lichtenstein, of the Bethlehem Shipbuilding Corp., presented an elaborate mathematical analysis of the losses and performance of a pump from the efficiency-capacity and horsepower-capacity curves.

The author showed how to develop the theoretical analysis employing the hydraulic efficiency, the whirl components of entrance and exit velocities, the real angle of the water leaving the blades at the exit, a case factor covering the influence of the volute on the action of the impeller, and the interial leakage.

He showed how these factors are to be determined from test and design data. His paper is highly theoretical, but is based on a study of actual test data. It should prove of value to pump designers who are interested in laying out pumps to meet pre-established characteristic curves.

Congressional Act Padlocks Colorado Development

One of the last bills passed by the Senate before adjournment was the resolution directing the Federal Power Commission to issue no permits or licenses under the water power act, "upon or affecting the Colorado River or any of its tributaries in the states of Colorado, Wyoming, Utah, New Mexico, Nevada, Arizona and California, until and unless the Colorado river compact, signed at Santa Fe, N. M., Nov. 24, 1922, has been approved by the Congress of the United States, or in the event that the compact is not sooner approved, until March 5, 1929."

The resolution had support in both the upper and lower basins of the Colorado. The upper states were anxious to prevent the possibility of establishing prior rights in the lower states and there was also the desire to make certain that no rights were acquired which would pave the way for the construction of the Boulder dam.

The resolution effectively padlocks the entire Colorado Basin. No rights may be granted on even the minor tributaries regardless of the fact that such projects would have no bearing on the Colorado River situation.

Muscle Shoals Bill Expires as Congress Ends

The offer of the Associated Southern Power Companies, which had the distinction of having made more legislative progress than any other Muscle Shoals bill, died with the Sixty-ninth Congress, March 4.

During the closing weeks of Congress the Military Affairs Committee of the House made an ineffectual effort to agree upon other legislation. The subcommittee on agriculture likewise was unsuccessful in efforts to provide for a further study of the Muscle Shoals problem or for limited government operation.

Germany Seeks International Electrical Combine

Admission by German electrical interests that they would welcome an international combination in their industry, which was reported from Berlin, was said in Wall Street, Feb. 20, to go a long way toward explaining why rumors of the possibility of such a merger continued to cross the Atlantic. The dispatch from Berlin was almost identical with two others received from Europe in recent months. These reports had been regarded as feelers put out by European interests to ascertain sentiment here. Their precise origin was not known until the receipt of the message from Berlin.

Officials of the General Electric Co. and the Westinghouse Electric & Manufacturing Co. again professed ignorance of any move to bring the world's electrical interests together. It was said that competition between these American companies was not especially keen in foreign markets and that the chief rivalry was between the American interests on the one hand and the European interests on the other.

Large Swiss Power Station Is Completed

Advices from Switzerland refer to the recent completion of the Verneyaz electric power station of the Swiss Federal Railways in Canton Valais. This brings to an end the construction of the Barberine-Vernayaz hydro-electric plant, the largest in Switzerland. Its aggregate production of energy will be over 180,000 hp.

The building and equipment of this plant—which is built on two levels—does great credit to the Swiss engineers and their workmen. Construction was begun in 1923, the Barberine lake was filled in 1925, the high level station at Chatelard was completed early in 1926, and the low level station of Vernayaz was finished by the end of December last.

The principal water reserve is formed by the artificial lake of Barberine, which lies at the foot of the Dent du Midi, at a height of 6,200 ft. It covers the former pastures and glen of Barberine and has been formed by the building of a concrete dam in the gorge of the torrent called the Eau Noire. The water of the lake is diverted into the Trient Valley, where, after a fall of 2,530 ft., it drives the turbines of the Chatelard plant, which produces some 62,000 hp. Then, increased by the waters of several torrents, the pipes descend along the Trient Valley to Salvan, where big compensation basins have been installed; thence the water falls a farther 2,187 ft. into the Rhone Valley and drives the powerful turbines of the Vernayaz plant, which is to yield over 115,000 hp.

The construction and equipment of the Barberine-Vernayaz plant has cost nearly $8,000,000. The aggregate capacity of the plant is 230 million kilowatt-hours, and this output costs about $1,420,000 a year.

The electricity produced by the Barberine-Vernayaz is transformed on the spot and distributed to the railways by several substations. The greater part of the power goes to the electrified lines of western Switzerland, while a small part is transported 80 miles northwards to feed the lines of northern Switzerland. The Barberine-Vernayaz power plant is also connected with the Amsteg-Ritom plant, on the St. Gothard line, a distance of 100 miles, so that its power can be distributed all over the network of the Swiss Railways.

Flue Gases Are Cleaned by Electric Precipitator

The first and only large installation of equipment for the electric precipitation of ash in a powdered-fuel boiler plant is being installed at the Trenton Channel power plant of the Detroit Edison Co. The installation, having what will probably be the highest power rating of any single electric precipitation of plant every built, is being made under the supervision of the Research Corp. of New York City, and involves the use of the Cottrell process.

Nine precipitator units will comprise the final installation, each being served by two 25-kva. electrical sets. Two precipitator units are already in use and the remainder will be installed early this year. The high-voltage power will be supplied from 18 specially designed, 25-kva. transformers, of which 14 units are now under construction by the General Electric Co. These units will step up the 220-volt single-phase 60-cycle power supply to 75,000 volts. The high voltage will then be passed through mechanical rectifiers, each driven by a synchronous motor of special design. The high-voltage direct current from the rectifier will be applied directly to the treaters.

The precipitators are of the graded resistance type, consisting of parallel grounded concrete plates between which will be suspended anodes connected to the negative side of the direct-current circuit. The positive side of the direct-current circuit will be connected to the concrete plates and a corona discharge will flow from the suspended anodes to the concrete cathodes. The flue gas will pass between the concrete plates, and the suspended ash will be ionized by the corona discharge and deposited on these plates whence it will be removed periodically by mechanical means, dropping into hoppers below.

Michigan University Issues Research Bulletins

The Department of Engineering Research of the University of Michigan, Ann Arbor, is publishing a series of numbered engineering research bulletins, of which five have appeared thus far. The first number is entitled "Investigation of Charcoal and Coke Pig Irons," by W. E. Jominy. The others, in order, are: "Volume Changes in Gypsum Structures Due to Atmospheric Humidity," by Alfred H. White; "The Neutral Zone in Ventilation," by J. E. Emswiler and W. C. Randall; "Stainless Steel: A Digest with Abstracts and Bibliography," by Albert E. White and Claude L. Clark; and "The Elements of Metal Cutting," by Orlan W. Boston. The price of each of the bulletins is 50 cents, except that of the last mentioned which is $1.

This department of the University of Michigan was established in October, 1920, upon the request of a number of manufacturers in the state who felt that the facilities of the University should be made available to the industrial and technical interests of the state to a greater extent than previously. The department is not at present prepared to conduct routine testing advantageously. The work is done by various members of the University staff and properly trained men appointed to fellowships for the study of specific problems. It is planned to publish the results of research that give promise of general interest.

Copies of the bulletins and information regarding the service are obtainable from the Director, Department of Engineering Research, Ann Arbor, Mich.

Refractories Institute Meets in May—Quarterly Sessions

Members of the American Refractories Institute attending this year's convention will meet at the Hotel Traymore, Atlantic City, N. J., on Wednesday, May 18, when the technical and business sessions will be held. A golf tournament is scheduled for the following day.

Four general meetings of the Institute during the fiscal year beginning in May was deemed necessary at the Feb. 17 meeting of the board of directors. The Institute is engaged in a number of activities which are in a very formative state, it has been pointed out. While four meetings a year may prove burdensome to some members, it is believed that the plan will give every member a chance to take an active part in the formation of specifications and in the rational development of tests and numerous other activities of a kindred nature.

Rate Reductions May Follow in Massachusetts

Reductions in rates charged by gas and electric light companies in Massachusetts "may reasonably be required," according to a special report submitted to the Legislature Feb. 14 by the state department of public utilities. The department recommends that it be given power to classify rates and to review the propriety of the rates and charges provided under special contracts.

Power Transmission Ass'n Shows Likely Growth

Progress during the last month in the formation and growth of the Power Transmission Association, a newly created organization of manufacturers in the power transmission field, included, according to report, the selection of W. S. Hays, 791 Drexel Building, electrical engineer formerly with the General Electric Co., as executive secretary. The organization has now over 100 members on its roster. W. H. Fisher, Chambersburg, Pa., is president.

Stevens Institute Buys Old Property for Expansion

Walter Kidde, acting chairman of the board of trustees of Stevens Institute of Technology, announced recently that the institute had purchased from the heirs of Richard Stevens seven acres of land at Castle Point, Hoboken, which has been in the Stevens family for 165 years. The newly acquired land, which will be used in the expansion of the institute, overlooks the old duelling grounds on the heights above the Hudson where Aaron Burr shot Alexander Hamilton. The purchase price was not announced by Mr. Kidde.

"Even though the purchase was made possible by the sympathetic attitude of the heirs of Richard Stevens," Mr. Kidde said, "We have assumed great financial obligation. We have provided for further expansion of the institute and at the same time preserved a noble tradition.

"When Edwin A. Stevens founded the institute as a mounment to his father, Col. John Stevens, and Robert L. Stevens, a brother, he hoped to see the land about it preserved as a unit and proper restrictions maintained. The purchase of this tract not only provides property much needed by the institute but honors three men who stood for the best combination of citizen and engineer, an ideal which found expression in the institute for more than half a century."

Industrial Engineers Plan May Convention

The Society of Industrial Engineers' fourteenth national convention will be held on May 25, 26 and 27 at Hotel Stevens, Chicago. "The Principles of Effective Management and their Relation to Industrial Engineering" will be the main theme.

Meetings will be held each morning and evening, the afternoons being devoted to the inspection of some of the most progressive plants in the Chicago district.

A feature of the convention will be an exhibition of charts, photographs, production control boards and allied devices, psychological test appliances and materials, and a special display showing what has been accomplished by some industries in simplification of their line of products.

All meetings will be open to the public. Programs may be obtained from S.I.E. headquarters, 608 S. Dearborn St., Chicago.

New Power Concern To Merge Fitkin Utilities

The organization of the Pinellas County Power Co., the Florida Power Corp. and the Central Florida Power & Light Co. into one company was announced at the offices of the National Public Service Corp., one of the Fitkin utility groups, Feb. 28. The merger involves properties appraised at approximately $20,000,000, and the united companies will be known as the Florida Power Corporation.

New Steam Plant in Building —Rochester Gas & Electric

Work has been begun on a new steam plant at Lincoln Park, Rochester, N. Y., by the Rochester Gas & Electric Corp., it was announced March 2 by Edgar R. Crofts, in charge of the construction work.

The new plant, in Mount Read Boulevard at the New York Central Railroad crossing, will be almost an exact reproduction of the company's Lawn Street station, Mr. Crofts announced.

The building will be 108 ft. in length and 70 ft. in width and will be approximately four stories in height, Mr. Crofts said. It will house two 1,000-hp. steam boilers. Plans have been arranged so that, as the demand increases, the plant will be expanded to accommodate additional boilers and equipment.

John B. Pike & Sons will be in charge of the general contract work. Carl C. Ade has made designs for the building.

Russia Lacks Adequate Power Equipment—Need Urgent

Within the next five years Russia must change the present equipment of her power plants, which total in capacity steam engines and steam turbines of combined 1,187,500 hp., internal-combustion engines, 18,845 hp. and steam boilers totaling 20,128,867 sq.ft. of heating surface, according to the report submitted by A. I. Sheftel, speaking at the annual meeting of the Russian Heat Engineers Society in convention at Moscow last November.

An immediate change, the report disclosed, must be made, involving 26½ per cent of the steam engines, 36½ per cent of the steam turbines and 29 per cent of all internal-combustion engines. Discussion of the report emphasized that Russian factories are unable to meet this requirement satisfactorily with their present equipment.

Preliminary Permits Sought for Power Projects

R. H. Woods, of Lordsburg, N. M., has applied to the Federal Power Commission for a preliminary permit covering a project on the Gila River in Hidalgo and Grant Counties, N. M. The plan contemplates the construction of five power houses and storage reservoirs. This would make available 50,000 hp., it is estimated.

The City of Allegan, Mich., has applied for preliminary permit covering a project on the Kalamazoo River in Allegan County. The application conflicts with that of the Fargo Engineering Co. The city proposes to install three 950 kva. units.

A license has been issued to the Pacific Gas and Electric Co. covering its constructed electra plant on the Mokelumne River.

Correction: What was reported in *Power*, page 384, March 8, as the largest stoker units ever built, to equip the new boiler plant of the University of Texas at Austin, are lignite stokers.

Commission Cannot Hire Own Personnel

After successfully running the blockade in the Senate the amendment to the water power act, which would have allowed the Federal Power Commission to hire its own personnel, failed of passage in the House. The Interstate and Foregin Commerce Committee considered the resolution during the closing days of the session, but did not act upon it.

Obituary

William C. Edwards, 63 years old, stationary engineer for the past 35 years for the Rothschild Brothers Hat Co., 1100 Washington Ave., St. Louis, Mo., died suddenly March 3, from heart disease.

C. J. Carle, who was secretary-treasurer of the Lagonda Manufacturing Co., Springfield, Ohio, died Feb. 6, at the age of eighty years. Mr. Carle has been associated with the projects of W. S. Elliott, president of Elliott Co., over a period of more than a quarter of a century. When Mr. Elliott organized the Liberty Manufacturing Co. in October, 1901, Mr. Carle was made manager of the new business. When the Elliott Co. took over the Lagonda Manufacturing Co. in 1916, Mr. Carle was made secretary-treasurer which position he held until his death.

William F. Clark, associated with the Superheater Co., 17 East 42nd St., New York City, as an erector of stationary superheaters, died Feb. 21. Mr. Clark was born Oct. 23, 1882, in Laddonia, Mo. He early prepared himself for his life work through earnest personal effort and application to problems pertaining to the erection and operation of combustion and power-plant equipment. For 20 years he was with the Green Engineering Co., in Chicago, then with the Brady Foundry & Machine Co. and the American Arch. He joined the Superheater Co. in September, 1925. He was a member of the Engineers' Society of Western Pennsylvania, and also a member of the National Association of Stationary Engineers.

Dudley Farrand, vice-president of the Public Service Corporation of New Jersey and its subsidiaries, died March 2. His home was at 49 Lincoln Park, Newark. Mr. Farrand was born in Bloomfield, N. J., February 21, 1869. In 1887, the year of his graduation from Newark Academy, Mr. Farrand, who had been entered at Princeton University, decided to start in business instead.

In 1899 he was general manager of the United Electric Co. of New Jersey and four years later he took the same position with the Public Service Corporation of New Jersey.

Mr. Farrand was a Fellow of the American Institute of Electric Engigineers, a former president of the National Electric Light Association and a member of the American Society of Mechanical Engineers, the Engineers Club, the Essex Club, the Newark Athletic Club, the Essex County Country Club and the Rumson County Club.

Personal Mention

Dr. D. S. Jacobus, consulting engineer of the Babcock & Wilcox Co., is enjoying a holiday with his family at Miami.

George E. Roberts, vice-president of the National City Bank, New York City, has been elected a member-at-large of the Engineering Foundation, it is announced by Chairman Lewis B. Stillwell. Mr. Roberts, succeeding Elmer A. Sperry, will serve three years.

Joseph J. Braun, formerly president and general manager of the Accurate Gear Corp., Brooklyn, N. Y., has taken up his new duties as chief engineer of the Micarta Fabricators, Inc., 307-11 Canal St., New York City, and general manager of the Accurate Gear division of this company.

Business Notes

The B. F. Sturtevant Co., manufacturer of fans, will move its New York office into the Graybar Building about April 1.

The Yarnall-Waring Co., manufacturers of power plant devices, announce that G. G. Sutton is now Southern district manager with headquarters at 1019 Atlanta Trust Co. Bldg., Atlanta, Ga.

The Link-Belt Company, of Chicago, Philadelphia and Indianapolis, opened a new branch sales office at 229 Brown-Marx Bldg., Birmingham, Ala., on March 6. W. H. Norton will assume the managership of the new territory.

The Chain Belt Co., Milwaukee, Wis., announces that George M. Dyke, who for some time has been assistant secretary, has been appointed treasurer of Stearns Conveyor Co. at Cleveland, Ohio, which some time ago was taken over by the Chain Belt Co. through purchase of all capital stock.

The Micarta Fabricators, Inc., 307-11 Canal St., New York City, has taken over the entire business and personnel of the Accurate Gear Corp., 273 Sackett St., Brooklyn, N. Y., and has created a new division of the general sales and engineering departments known as the Accurate Gear Division.

The Sullivan Machinery Co. has appointed O. J. Neslage, of the St. Louis Office sales staff, local manager at Mexico City, Edificio Oliver No. 3. A. W. Oakes, for several years past manager at Mexico City, has been assigned to a post in the United States. C. W. Miller has been appointed special representative in Cuba and will cooperate with the company's general agents, the Purdy & Henderson Trading Co., Habana 55, esquina a Empedrado, Havana, Cuba.

The Trico Fuse Manufacturing Co., Milwaukee, Wis., manufacturer of Trico renewable fuses, announces the appointments of B. M. Slicting as sales promotion manager in charge of the sales promotion work at the company's main office in Milwaukee; J. E. Eldredge, as sales representative for the State of Connecticut and the western part of Massachusetts, and Arthur E. Bacon, of 1429 Eighteenth St., Denver, Colo., as salesman for the States of Colorado, New Mexico, Utah and Wyoming.

The Barrett Machine Co., which recently purchased the entire valve specialty business of the A. W. Cadman Manufacturing Co., Pittsburgh, Pa., including their Cadman gate valve, Cadman blow-off valve, gage cocks and coke oven valves is now in a position to make immediate shipment of all sizes and types of valves.

Coming Conventions

American Association of Engineers. Annual convention, Tulsa, Okla., June 6-8; M. E. McIver, 63 East Adams St., Chicago.

American Institute of Electrical Engineers. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Kansas City, Mo. regional meeting March 17-18, Bethlehem, Pa. regional meeting April 21-23, Pittsfield, Mass. regional meeting May 25-27. Summer convention at Detroit, Mich., June 20-24 inclusive; Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

American Oil Burner Association. Annual convention and exposition at Buffalo, N. Y., April 5-7.

American Order of Steam Engineers. Annual convention, Moose Hall, 1314 North Broad St., Philadelphia, Pa. June 13-16; J. E. Burke, c/o Burke Boiler Repairing Co., 1821 So. Ringgoldl St., Philadelphia.

American Refractories Institute. Spring meeting at Hotel Traymore, Atlantic City, N. J., May 18-19; D. A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh, Pa.

American Society of Civil Engineers. George T. Seabury, secretary; Spring convention at Asheville, N. C., April 20-22. Annual convention at Denver, Col. July 13-15.

American Society of Mechanical Engineers. Spring meeting at White Sulphur Springs, W. Va., May 23-26. Calvin W. Rice, secretary. Midwest regional meeting will be held in Kansas City, April 4-6 inclusive; F. S. Dewey, chairman of the Kansas City Section.

American Society of Refrigerating Engineers. Western meeting at White Sulphur Springs, W. Va., May 23-25, in conjunction with the Spring meeting of the A.S.M.E.; W. H. Ross, 35 Warren St., N. Y.

American Water Works Association. W. M. Niesley, assistant secretary, 170 Broadway, N. Y. Annual convention Hotel Sherman, Chicago, June 6-11.

American Welding Society. Annual meeting at 29 West 39th St., New York City, April 27-28-29.

Association of Iron and Steel Electrical Engineers. Annual convention in conjunction with Iron and steel exposition at Pittsburgh, Pa., June 13-18, inclusive.

Heating and Ventilating Exposition. Will be held at Twelfth Regiment Armory, New York City, March 14-19 inclusive.

National Association of Practical Refrigerating Engineers. Annual convention probably in November; E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Association of Stationary Engineers—Annual convention, in conjunction with the Pacific Coast Power Show, will be held at the Ambassador Hotel, Los Angeles, Calif., Aug. 22-27 inclusive, John Topman, secretary, convention committee, Ohio State annual convention in Memorial Hall, Lima, Ohio, June 16-18, inclusive, in conjunction with the Northwestern Ohio Power Show; P. H. Grigsby, secretary of convention committee, Lima, Ohio. New England States convention at Portland, Me., June 17-18. Thomas H. Clark, president, Worcester, Mass.; Robert Johnson, secretary, 65 Charlotte St., Worcester, Mass. Indiana State convention at Anderson, May 27-28.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Nashville, Tenn., June 8.

National District Heating Association. Annual convention at West Baden Springs, West Baden, Ind. May 17-20; D. L. Gaskill, secretary, Greenville, Ohio.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Convention at Atlantic City, June 6.

Universal Craftsmen Council of Engineers. Thomas H. Jones, secretary, 33 Linden Ave., Cherrydale, Va. Annual convention at Buffalo, N. Y. Aug. 2-6.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Mar. 7 1927
Pool 1	New York	$2.75@$3.25
Smokeless	Boston	1.63
Clearfield	Boston	1.65@ 2.00
Somerset	Boston	1.80@ 2.15
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.65@ 1.90
Pittsburgh	Pittsburgh	1.80@ 1.90
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.50@ 2.75
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.40@ 2.50
West Ky.	Louisville	1.40@ 1.75
S. E. Ky.	Louisville	1.40@ 1.75
Big Seam	Birmingham	1.50@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1.	New York	2.75@ 3.00
Buckwheat No. 1.	Philadelphia	2.75@ 3.75
Birdseye	New York	2.00

FUEL OIL

New York—March 10, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¼c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Mar. 1, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.05 per bbl.; 26@28 deg., $2.10 per bbl.; 28@30 deg., $2.15 per bbl.; 30@32 deg., $2.20 per bbl.; 32@36 deg., gas oil, 5.91c. per gal.; 38@40 deg., 6.75c. per gal.

Pittsburgh—Mar. 2, f.o.b. local refinery; 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6.75c. per gal.

Philadelphia—Mar. 2, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.90@$1.96 per bbl.

Cincinnati—Feb. 28, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 6¼c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Feb. 28, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.27½ per bbl.; 26@30 deg., $1.35; 30@32 deg. $1.65.

Boston—Feb. 28, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.85c. per gal.; 28@32 deg., 6c. per gal.

Dallas—Feb. 26, f.o.b. local refinery, 26@30 deg., $1.75 per bbl.

The Botfield Refractories Co., Philadelphia, Pa., has engaged Frank J. Donnelly to cover the New Jersey territory under the direction of Charles C. Phillips, New York district manager. Mr. Donnelly will co-operate with users of Adamant firebrick cement.

The Central Automatic Sprinkler Co. following the death of the former president, L. Lewis, has made the following changes in its board of directors and management. Those now directors are Leroy M. Lewis, E. O. Lewis, Charles Chrstos, R. G. Wheeler and E. E. Zimmerman. The officers are president and assistant treasurer, Leroy M. Lewis; vice president, E. O. Lewis; treasurer, Charles Chrstos; secretary, R. G. Wheeler.

The Foote Bros. Gear & Machine Co. announces the following additions to its distributing organization: The Interstate Machinery & Supply Co., 1006 Douglas St., Omaha, Neb., has been appointed representative for IXL products in Omaha, the eastern half of the State of Nebraska and the west portion of Iowa; W. L. Hutcheson, 201 E. California St., Oklahoma City, Okla., for Oklahoma City and the northern half of the State of Oklahoma; Nashville Machine & Supply Co., 123-135 Third Ave., North, Nashville, Tenn., distributor for Nashville and the central part of the State of Tennessee, and Hollis & Co., 305-11 E. Markham St., Little Rock, Ark., distributors for the city of Little Rock and vicinity.

Trade Catalogs

Gears for Centrifugal Compressors—The General Electric Co. describes and illustrates gears for centrifugal compressors in bulletin GEA-588.

Medium-Speed Synchronous Motors—The General Electric Co., in GEA-708, treats of medium-speed synchronous motors, "7600 series," types TS (3-phase), QS (2-phase), 514 to 900 r.p.m., 100 to 700 hp.

Water Jet Eductors—The Schutte & Koerting Co., Philadelphia, Pa., has issued a bulletin, No. 2-M, describing water-jet eductors, water-operated cesspool pumps, sand washers, etc. Many of the applications of jet pumps used in plants are illustrated with figures, charts and accompanying tables.

Stable-Arc Welding — The Lincoln Electric Co., Cleveland, Ohio, has just issued the 1927 edition of the "Lincoln Stable Arc Welder Instruction Manual." This book covers the installation and maintenance of the Lincoln stable arc welder and includes nine lessons in arc welding. Among the subjects treated are high-speed steel welding, high-pressure pipe welding, automobile frames, boiler repairs, welding cast iron, manganese-steel welding, carbon arc welding, manufacture of machinery and equipment using welded steel in place of castings.

Blowoff Valves—Riley Power Equipment Co., Milwaukee, Wis., sole distributor of the Eckenroth automatic reseating blowoff valve, has issued a four-page folder descriptive of this product. A distinctive feature to insure tightness is the provision for rotating the disk on the seat under a definite spring pressure.

Multi-Pointer Gages for Draft and Other Factors is the title of a 16-page bulletin recently issued by the Bailey Meter Co., of Cleveland, Ohio. This bulletin is a revision of a former edition describing gages which may be used for indicating low, medium and high pressures, as well as temperature, differential draft or pressure, speed and rate of flow. They may also incorporate units designed for operating signal devices, units for indicating water level in storage tanks and depth indicators for use aboard ship. They may be used for boiler pressure, feed-water pressure, and various pressures and vacuums in a turbine system. Indicating flow units for feed water, steam, air, gas, etc., can also be incorporated.

New Plant Construction

Calif., Los Angeles—F. Horowitz, Stock Exchange Bldg., is having plans prepared for the construction of a 12 story office and loft building including steam heating and sprinkler systems, elevators, etc., at 7th and San Julian Sts. A. Weitzman, 1401 Hibernian Bldg., is architect.

Calif., Los Angeles—University of Southern California, 3551 University St., is having preliminary plans prepared for the construction of a group of college buildings including steam heating system, etc. on Campus. Estimated cost $900,000. J. & D. B. Parkinson, 420 Title Insurance Bldg., are architects.

Calif., Modesto—Modesto Ice Delivery Co., is having plans prepared for the construction of an ice and cold storage plant. Estimated cost $75,000.

Calif., San Francisco—City plans an election to vote $800,000 to $1,000,000 bonds for the construction of a step-down power plant in connection with Hetch Hetchy power project. M. M. O'Shaughnessy, is city engineer.

Conn., Hartford—Hartford Electric Light Co., 266 Pearl St., awarded contract for design and construction of extension to their South Meadow Station including installation of boilers, turbine and auxiliaries, to Stone & Webster, 120 Broadway, New York, N. Y. Estimated cost $2,000,000.

Conn., New Haven—New Haven Oil Corp., 252 Asylum St., awarded contract for the construction of a boiler house. Estimated cost $40,000. Private plans.

D. C., Washington—Bureau of Standards, Dept. of Commerce, will soon award contract for the construction of laboratory power building.

Fla., Avon Park—Florida Public Service Co., A. P. Campbell, Engr., has acquired a site and plans the construction of a power plant. Estimated cost $2,041,000.

Fla., Leesburg—City Comn., plans an election to vote $45,000 bonds for improvements to ice plant to increase the capacity to 20 ton daily.

Ill., Chicago—W. C. Bannerman & Co., 77 West Washington St., awarded contract for masonry, etc. for a 16 story apartment building including steam heating system, 6 elevators, etc. at Wellington Ave. and Sheridan Rd. Estimated cost $3,500,000.

Ill., Chicago—Chicago Daily News, 15 North Wells St., is having sketches made for the construction of a 24 to 26 story plant and office building at Madison, Canal and Washington Sts. Estimated cost $20,000,000. Architect not announced.

Ill., Chicago—E. J. Meles, 105 West Monroe St., Archt., will soon receive bids for the construction of a 13 story, hotel including steam heating, ventilation and refrigeration systems, elevators, etc. for B. E. Cohen, 139 North Clark St. Estimated cost $2,000,000.

Ill., Chicago—S. Olson, 721 Belmont Ave. and A. H. Loeffler, 2738 Pine Grove Ave., will soon receive bids for the construction of a 14 story hotel including steam heating system, central refrigeration plant, 2 elevators, etc. at 2734 Pine Grove Ave. Estimated cost $1,200,000. Thielbar & Fugard, 219 East Superior St., are architects.

Ill., Evanston — Homestead Apartment Hotel Co., c/o P. A. Danielson, 1569 Sherman Ave., Archt., is having plans prepared for the construction of a 7 story hotel including steam heating and refrigeration systems, 2 elevators, etc. at 1625 Hinman Ave. Estimated cost $750,000.

Ill., Glenellyn—C. Ganzhorn, 583 Main St., awarded contract for the construction of an apartment building on Park Blvd., to G. W. Drollinger & Sons, 4753 West Madison St., Chicago, Ill. Estimated cost $500,000. Steam heating system will be installed.

Ind., Anderson — Anderson Engine & Foundry Co., E. F. Cooney, Gen. Mgr., Second and Jackson Sts., plans the construction of a power and light plant. Estimated cost $35,000.

Ind., Gary—Ivar Viehe-Naess & Co., 410 North Michigan Ave., Chicago, Ill., Archts., will receive bids about Mar. 15 for the construction of a 10 story bank and office building including steam heating system elevators, etc. at Broadway and 5th St. for Gary State Bank. Esitmated cost $600,000.

Ia., Audubon—City plans the construction of a waterworks system including pumping equipment, mains, etc. Estimated cost $50,000. W. E. Buell & Co., 205 Davidson Bldg., Sioux City, are engineers.

Ia., Decorah—Interstate Power Co., plans the construction of a power house and tunnel, also improvements to dam. Private plans.

Ky., Louisville — U. S. Engineer Office, War Dept., Washington, D. C., will receive bids until Mar. 21, for the superstructure for power houses at Dams 50, 52 and 53 on the Ohio River, here.

La., Baton Rouge — Louisiana Ice & Utilities Co., Simmesport, awarded contract for the construction of an ice plant here, to A. C. Stewart, 810 East Boulevard, Baton Rouge. Estimated cost $85,000.

Md., Baltimore—Federal Reserve Bank of Richmond, Va., will soon award contract for the construction of a 5 story bank and office building including steam heating system, elevators, etc., at Calvert and Lexington Sts. Estimated cost $1,000,000. Parker, Thomas & Rice, Richmond Union Trust Bldg., are architects.

Md., Hagerstown—Bd. of Street Comrs., will soon award contract for the construction of an electric plant. L. T. Klander, Bankers Trust Bldg., Philadelphia, is consulting engineer.

Mich., Detroit—Murphy Estate, Penobscot Bldg., will receive bids about Mar. 10 for the construction of a 45 story office building including steam heating, refrigeration and ventilation systems, boilers, elevators, etc. at Fort and Griswold Sts. Smith Hinchman and Grylls 800 Marquette Bldg., and Donaldson & Meier, 1314 Penobscot Bldg., are architects.

Mich., Flint—Frankay Corp., is having plans prepared for the construction of an 8 story hotel including steam heating and ventilation systems, boilers, elevators, etc., at Detroit St. and Third Ave. Estimated cost $500,000. C. N. Agree, 1140 Book Tower, is architect.

Minn., Minneapolis—W. B. Foshay Co., 9th St. and 2nd Ave., plans the construction of a 12 story office building including steam heating system, elevators, etc., at 9th and Marquette Sts. Estimated cost $750,000. Magney & Tusler, 126 South 9th St., are architects.

Minn., Thief River Falls—City awarded contract for rebuilding power plant to double present capacity of 350 hp., to McKenzie-Hague Co., Corn Exchange Bldg. Estimated cost $46,975.

N. H., Concord—J. D. Leland & Co., Statler Bldg., Boston, Mass., Archts., will receive bids until Mar. 22 for the construction of addition to hospital nurses' home, power house, etc. here, for Margaret Pillsbury General Hospital, Concord, N. H. Estimated cost $150,000.

N. J., Phillipsburg—Bd. of Education, will soon award contract for the installation of a steam heating and ventilation plant in high school. E. Sibley, Palisades, is engineer.

N. J., Trenton—Public Service Electric & Gas Co., c/o Public Service Co., East State St., plans improvements to North Warren St. generating station, also Liberty Street sub-station. Esimated cost $250,000.

N. Y., Matteawan (mail Glenham)—Dept. of Mental Hygiene, Albany, will soon award contract for the construction of a central power plant for Matteawan State Hospital here.

N. Y., New York—Anthony Campagna, 200 West 72nd St., will build a 14 story apartment including steam heating system, elevators, etc. at 2 East 70th St. Estimated cost $2,500,000. Walker & Gillette, 128 East 37th St., are architects.

N. Y., New York—National City Bank, 55 Wall St., awarded contract for the construction of a 31 story bank and office building at 52 Wall St., to George A. Fuller & Co., 949 Broadway. Estimated cost $8,000,000. Steam heating system, elevators, etc. will be installed.

N. Y., Oswego—Water Service Comm., W. J. Dowdle, Pres., City Hall, will receive bids until Mar. 25 for the construction of a hydro-electric development near west end of Barge Canal 6.

O., Columbus—King Rogers Arms Co., 578 East Tower St., is having plans prepared for the construction of a 10 story hotel including 4 elevators, etc. Estimated cost $1,200,000. R. C. Hanford, 683 East Broad St., is architect.

O., Toledo—Toledo Furnace Co., Front St., awarded contract for the construction of a power plant to Dwight P. Robinson & Co., Inc., 125 East 46th St., New York, N. Y. Estimated cost $1,000,000. Installation includes three 2,000 hp. and two 1,500 hp. boilers, 10,000 kw. generator, etc.

Okla., Lawton — Southwestern Light & Power Co., Braniff Bldg., Oklahoma City, is receiving bids for the construction of a 40 ton ice plant, here. R. H. Oliver, 115 South Dearborn St., Chicago, Ill., is architect.

Okla., Tulsa — W. Phillips, Petroleum Bldg., awarded contract for the construction of a 20 story office building to Long Construction Co., 600 Rialto Bldg., Kansas City, Mo. Estimated cost $2,500,000.

Pa., Philadelphia—Hobnemann Hospital, W. E. Herring, Pres. Bd. of Trustees, is having plans prepared for the construction of a 17 story hospital at Board and Vine Sts. Estimated cost $2,000,000. H. H. Marshall, 37 West 43rd St., New York, N. Y., is engineer.

Tex., Amarillo — Southwestern Public Service Co., is having preliminary plans prepared for the construction of second unit of power plant, also extensions and improvements to transmission lines, etc. Estimated cost $2,000,000. Private plans. Equipment will be required.

Tex., Bedias—Western Public Service Co., has acquired an electric light plant and plans extensions and improvements. Estimated cost $15,000. Private plans.

Tex., Big Lake—City plans an election to vote $40,000 bonds for the construction of a new waterworks system including pumping equipment, mains, etc.

Tex., Estelline—Central Power & Light Co., Frost Bldg., San Antonio, plans the construction of a power plant and dam, 1,500 ft. wide and 175 ft. long here. Estimated cost $1,000,000. Private plans.

Tex., Honey Grove—City plans an election Mar. 15 to vote $100,000 bonds for waterworks improvements including pumping equipment, mains, etc. Engineer not selected.

Tex., Lockney—City plans an election to vote $25,000 bonds for waterworks improvements including pumping equipment, mains, etc. Hawley & Roberts, Box 1115 Lubbock, are engineers.

Tex., Nixon — T. A. Closlitzer, New Braunfels, is having surveys made for extensions and improvements to light and power plant including 150 hp. addition to increase the capacity to 300 hp., here. Estimated cost $60,000. Private plans. Machinery and equipment will be required.

Tex., San Benito—Dixie Development Co. plans to develop 12,521 acres of land including the construction of waterworks and distribution systems, electric light plant, etc. at Laguna Madre near San Benito. Estimated cost $1,000,000. Hare & Hare, Huntzinger Bldg., Kansas City, Mo. and W. E. Anderson, San Benito, Tex., are engineers.

Tex., Victoria—Texas Central Power Co., Frost Bldg., San Antonio, has made application to State Board of Water Engineers for permit to construct a dam, 35 ft. high and 300 ft. long on the Guadalupe River near here. Estimated cost $1,000,000. Private plans.

Tex., Webb—G. Blount & L. Swift, Nacogdoches, is having preliminary plans prepared for development of 80,000 acres of land including irrigation system, pumping equipment, etc. Estimated cost $3,000,000. Private plans.

Wash., Seattle—Lake Forest Park Water Co., will readvertise for bids for waterworks improvements including pump house, etc. W. F. Batcheller Inc., Dexter Horton Bldg., is engineer. Former bids rejected.

Wis., Stoughton—City, E. Norman, Clk, will build a hydro-electric plant by day labor. Estimated cost $40,000. Power Engineering Co., 621 Metropolitan Life Bldg., Minneapolis, Minn., is engineer. Contract for electrical equipment awarded.

Ont., Windsor—Norton-Palmer Hotel Co., Jefferson and Griswold Sts., Detroit, Mich., awarded contract for the construction of a 12 story hotel at Park and Pelissier Aves. to W. H. Yates Construction Co., Windsor, Ont. Estimated cost $700,000. Steam heating and ventilation systems, boilers, elevators, etc. will be installed.

Equipment Wanted

Boilers, Pumps, Etc.—Detroit Creamery, Grand River and Cass Aves., Detroit, Mich., is in the market for complete operating equipment including boilers, pumps, etc. for power plant in connection with proposed new milk condensery.

Cold Storage Equipment—East Texas Public Service Co., Marshall, Tex., will purchase complete machinery and equipment for proposed cold storage plant. Estimated cost $40,000.

Ice Plant Machinery—W. J. McKnight, et al, San Augustine, Tex., will purchase machinery and equipment for proposed 40 ton ice plant at Hemphill, Tex. Estimated cost $50,000.

Ice Plant Machinery—Southern Ice & Utilities Co., Texarkana, Tex., is in the market for electrically operated machinery for proposed 100 ton ice plant. Estimated cost $300,000.

Motor Generator Set, Transformers, Etc.—Dept. of Public Works, Wellington, N. Z., is in the market for one synchronous motor generator set complete with switch gear and all necessary accessories; will also receive bids until Apr. 5, for 400 to 500 kva. single ph. transformers with one type terminals for outside service, or alternately 400 to 500 kva. single ph. transformers with cable boxes on both H. T. and L. T. side.

Motors—H. G. Denton, Clk, Sacramento, Calif., will receive bids until Mar. 24 for two speed motors for sewage pumping station.

Oil Engine, Etc.—City of Imperial, Neb., plans an election Mar. 15, to vote $25,000 bonds for the installation of an oil engine and other equipment in water and light plant.

Power House Equipment — Circle Bar Knitting Co., Kincardine, Ont., prices and catalogs on complete equipment for new power house in connection with silk hosiery factory at Owen Sound, Ont. Estimated cost $50,000.

Pump—Dept. of Waterworks, Hamilton, O., is in the market for a 7,000,000 g.p.m. centrifugal pump.

Pump, Engine, Etc.—Peoples Iowa City Waterworks Corp., G. J. Keller, Mgr. Iowa City, Ia., will soon receive bids for low pressure pump, engine, etc. for proposed waterworks improvements. Estimated cost $75,000.

Pump, Etc.—Village of Laingsburg, Mich., is having preliminary plans prepared for the installation of an electrically operated pump, etc. for proposed waterworks improvements. Estimated cost $15,000.

Pumps, Etc.—Village of Rocky River, O., is having plans prepared for the installation of pumps, etc. for proposed waterworks improvements. Estimated cost $25,000.

Pumping Equipment—Bd. of Local Improvements, Marion, Ill., will receive bids about Mar. 28 for pumping equipment, etc. in connection with proposed sewage disposal plant. Estimated cost $83,207.

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